PAYLOAD OPERATION TELEVISION SYSTEM

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FINAL REPORT

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PREPARED FOR

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ASTRO-ELECTRONICS DIVISION
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1.0 PROJECT GOALS AND INTENDED USE

The Payload Operation Television System is a high performance closed-circuit TV system designed to determine the feasibility of using TV to augment purely visual monitoring of operations, and to establish optimum system design of an operating unit which can ultimately be used to assist the operator of a remotely manipulated space-borne cargo loading device. The TV system assembled on this program is intended for laboratory experimentation which would develop operational techniques and lead to the design of space-borne TV equipment whose purpose would be to assist the astronaut-operator aboard a space station to load payload components. These could have been flown to the space station via a shuttle craft. Large articulated arms, remotely controlled from within the space station could be used to grapple payload units and load them into a cargo bay through an opening in the space station side wall. The laboratory TV system will enable operators to develop and demonstrate skill in conducting such a manipulation depending on observations of a television image. The TV system assembled for this program is a black and white, monocular, high performance system.

The equipment consists principally of a good quality TV camera capable of high resolving power; a TV monitor; a sync generator for driving camera and monitor; and two pan/tilt units which are remotely controlled by the operator. One pan/tilt unit provides control of the pointing of the camera, the other similarly controls the position of a simulated payload.

The use of the laboratory model closed-circuit TV system should be useful in training operators, developing techniques for remote manipulation and should provide suggested improvements or modifications in system design.

2.0 DESCRIPTION OF EQUIPMENT

2.1 Overall System - The following items are deliverable as part of the program:

a) Black/white camera with lenses and connecting cables.

b) Black/white television monitor

c) Synchronizing generator

d) Video cursor

e) Control assembly with connecting cables

f) Camera pan/tilt unit with cables

g) Camera tripod

h) Pan/tilt unit for satellite model with cables

i) Tripod for satellite model

j) Satellite Model No. 1

k) Satellite Model No. 2

l) Two lighting units

2.2 Sources - The sources selected for the purchased items of equipment are the following:

a) <u>Television Camera</u>: Sierra Scientific Corp; model LSS-1 with RCA silicon vidicon, type 4532A.

b) <u>Black and White Television Monitor</u>: CONRAC Inc., 14-inch diagonal model, RQB 14/RS.

c) <u>Synchronizing Generator</u>: Grass Valley Group, Inc. model 950 ElA sync generator, model 910 Pulse distribution amplifier, model 900 PS-1 Power Supply, model 90170 Mounting Trak.

d) Pan/Tilt Units for Camera and Satellite Models - Vicon Industries; Variable Speed Pan/Tilt Drive, model V350 PTV. Proportional joystick controls, model V121 PTR. Position Readout Control, model V124 PR. Servo unit for locking together the motion of the two heads. Feedback Option for Variable Speed Drive, model VPR. (Modified for offset angle control).

e) Camera and Models Tripods - Quick Set Inc; Tripod and Elevator, Part No. 4-53021-8, Hercules Series.

f) Lighting Units

- Smith-Victor, Floodlight Part #A12UL
- Tripod S3
- Mole-Richardson, Spot Lamp Part 4801
- Folding Pedestal Part S41

g) Cabinet Rack - Almo Industrial Electronics, Upright Cabinet Rack, Series 60 and accessories.

h) Lenses - Schneider, CM-120 fixed focus, 35 mm f/2, Xenon. CANON USA, zoom lens focal lengths 18 to 108 mm f/2.5 model V6 x 18.

2.3 Physical Construction - Most of the equipment is mounted in a cabinet rack with a shelf at desk height. The pan/tilt controls are mounted at the back of the desk top and the monitor is mounted near the top of the rack for viewing at easy eye range by the operator and others behind him. The control of the cursor generator is mounted under the monitor, and the sync generator is mounted below the desk-shelf, since these controls do not require continuous adjustment. The camera control is above the monitor. The position indicating units for the pan/tilt heads are mounted in small separate

cabinets beneath the operating shelf where they are not readily viewed by the operator. These two units give an angular indication of the two pan/tilt heads which are mounted on individual tripods. On one head is the camera and on the other is one of the two satellite models. One of the models is two feet in diameter and six feet long, with mounting on the side of the cylinder. The other is 2-1/2 feet in diameter and four feet long with the mounting to the pan/tilt unit at one end of the cylinder.

2.4 Operational Controls for Pan/Tilt - The pan/tilt control units have a single lever or joystick control which makes possible the simultaneous control of both pan and tilt operations. The two joystick controls may be operated independently, one controlling camera position and the other controlling satellite model. Also the satellite model control may be slaved to the camera position control causing the two pan/tilt heads to operate in unison. By causing the simulated payload to move in the same manner as the cameras it is possible to create on the monitor of the TV system an image which appears to be translated across the picture format, thereby simulating side-wise motion of the payload. Offset angle controls for both pan and tilt are provided. In the slaved mode an additional angular increment can be added to the satellite position and varied.

2.5 Cursor Generator - In addition to the above named commercially available equipment a cursor generator was designed to be used as part of the system. This mixes a signal with the video signal which forms bright lines on the monitor picture. A pair of horizontal lines may be separated at a choice of distances vertically; and a pair of vertical lines may be similarly varied in horizontal separation. Thus the four lines can be adjusted to define a critical area on the monitor. This could represent, for example, the defining

perimeter of the door opening into the payload bay. Also, provided is a single line which can be rotated about the center to a desired angle with the horizontal, either originating at the center or extending from edge-to-edge of the scanned raster.

With this system the operator may set up visual operating limits for the manipulating arms and then change these limits as the camera is panned or the lens is "zoomed in" on the payload. The rotating vector line can be set up as a line passing through the pictorial vanishing point, and can be used as a reference for the angular control of the payload model.

3.0 SYSTEM SPECIFICATIONS

3.1 General - The unit is self contained in the sense that only input power (110-120 volt 60 Hz) is required for its operation, however, it is capable of operating from an external synchronization source. The sync format is EIA-RS-170. An RS-170 sync is also available for driving additional TV equipment. The video format is 525 lines with a 2:1 interlace.

3.2 Camera Performance

3.2.1 Camera Sensitivity - The useful average brightness range of scene input is one foot-lambert to 1000 foot-lamberts. A lens aperture variable between f/2.5 and f/22 (f/2 to f/22 for the fixed focus lens) and a gain control, in the camera amplifier permit a combination of manual and automatic control to assure proper vidicon exposure. The value of this exposure is nominally 5×10^{-2} foot-candles on the faceplate.

3.2.2 Camera Resolution - The camera resolution meets the requirement of greater than 0.25 MTF at 300 TV lines per picture height at this level of illumination. (See Section 6.0, Results, for actual camera performance above these limits.)

For a faceplate illumination of 1 x 10^{-1} foot-candles the MTF is better than 0.3 at 300 TV lines. A further requirement which is met, is that the system including the monitor permits the display of this resolution without degradation.

3.2.3 Camera Shading - The picture shading using the camera is less than 15% as required by the specification. See Section 6.0.

3.2.4 Camera Signal-to-Noise Ratio - The S/N at the output of the camera is at least 35 dB when a faceplate illumination of 0.1 foot-candle is used.

3.2.5 Camera and System Geometric Distortion - The system was designed to achieve a combined camera and monitor linearity error of less than 1%. In actual practice the scan linearity for this system does not exceed 2% in the worst position. For definitive measurement see Section 6.0.

3.3 Lens Requirements - The fixed focus lens has 35 mm focal length, f/2 aperture ratio which is in accordance with the contract specifications. The zoom lens has a range of focal lengths between 18 mm and 108 mm with an aperture ratio of f/2.5. This more than meets the specification which is 20 or more mm to 80 or 120 mm with an aperture ratio f/4 or better. Both lenses are fitted to use a "C" mount.

3.4 Monitor Requirements - The monitor is 14-inch diagonal, larger than the 12-inch minimum required by specification, and has a separate brightness control; however, it has an internal sync separator and will operate from video with mixed sync, or from external sync. A sync generator unit is provided for the camera and monitor. The monitor will respond properly to an RS-170 sync format.

3.5 Video Cursor Generator Characteristics - The cursor generator is designed to provide marking lines on the monitor which have a width of one scan line interval.

The cursor lines generated are in accordance with the contract specifications which are itemized in the following sections.

3.5.1 Dual Vertical Lines - With their own brightness control, and a control knob which controls the separation of the two lines equidistant from the picture center.

3.5.2 A Single Vertical Line - Which has its own brightness control and a knob for determining its position on the display.

3.5.3 Dual Horizontal Lines Cursors - Which are controlled in brightness by a control knob, and in separation, equidistant from the center, by a second knob.

3.5.4 A Single Horizontal Line - Which may be controlled in brightness and in vertical position.

3.5.5 A Single Cursor Line - Which is controllable in brightness and which originates at the picture center, or which can be made to extend through the picture center to the edge of the picture, and which is rotatable about the center position through 360°.

3.5.6 Optical Center Electronic Marking - Center cross hairs which are electronically generated and which may be controlled in brightness.

3.5.7 Controls - All of the above lines and line combinations can be operated singly or simultaneously.

3.5.8.1 Video Cursor Generator - The video cursor generates lines which appear in the video display, which are controllable in position and brightness. The cursor generator requires two signals from the sync generator: composite blanking and vertical drive. Video cursors requiring symmetry about the optical center mark are controlled horizontally by the vertical cursor logic control and vertically by the horizontal cursor logic control. This will produce both vertical and horizontal dual-line cursors which remain symmetrical about the optical center mark while varying their distance from the center mark. Single-line cursors will not be under the control of the symmetry modules and may be positionally adjusted independent of the optical center mark. All video cursors may be selected independently, and any number of them may be added to the NTSC video signal in the additive mixer to produce the signal for the monitor display. A separate cursor output is provided for use external to the TV system.

3.5.8.2 Symmetrical Vertical Cursor Module - The symmetrical vertical cursor module maintains symmetry of the dual vertical line cursor, horizontal center mark and rotating vector cursor about the horizontal center.

Horizontal blanking is used to trigger a monostable multivibrator (U1) which in turn will trigger a second monostable circuit (U2). The output of U2 is adjusted to produce a symmetrical square wave, the position of which is adjusted by U1. The center of the square wave determines the location of the vertical center mark.

A triangular waveform generator transforms the square wave into a triangle which is then compare (U3) with an adjustable reference to produce a variable width pulse that is symmetrical about the horizontal center. The edges of this pulse trigger a monostable circuit for 100 nanoseconds, or approximately one television

element in width. The resulting two pulses produce the dual vertical line cursor. These two pulses can be positioned by adjusting the reference voltage of U3.

The center transition of the square wave (U2 output) triggers monostable U5 for 100 nanoseconds. This pulse is gated with a height control pulse derived in the center symmetrical horizontal cursor module and produces the vertical optical center mark.

Another comparator (U4) compares the triangular wave with a fixed reference to develop a pulse which controls the width of the horizontal optical center mark. In this manner, the horizontal center mark will remain symmetrical about the vertical center mark when adjustment is made to position the square wave (vertical center mark adjustment).

All outputs are gated with composite blanking to inhibit video cursors during the blanking intervals.

3.5.8.3 Center Symmetrical Horizontal Cursor Module - Operation of this module is quite similar to that of the vertical module except for the difference caused by the 2:1 interlace. To ensure display of a full single horizontal line, the comparator (U3) is used to trigger a 1/2 H monostable (U4). The monostable, in turn, enables a J-K flip-flop which is clocked by the composite blanking signal.

The position of the horizontal optical center mark is controlled by adjusting monostable U1, position of the dual horizontal line cursor by adjusting the reference voltage for comparator U3, and symmetry of the vertical center mark about the horizontal optical center is controlled by the vertical center mark height control.

3.5. 8.4 Single Vertical and Horizontal Line Cursor - Two monostables are utilized to position the single line and control the width of the displayed line. Adjustment can be made to position the vertical line in the monitor display from left edge to right edge and the horizontal line from top to bottom.

3.5.8.5 Rotating Cursor - Following the course of a vector rotating about the optical center mark and defining zero degrees as located at the center top of the monitor display, the vector has zero slope at 0° and 180°, and a discontinuity in slope at 90° and 270°. This describes a tangent function for the vector where the angle (Θ) of the vector is $\Theta = \tan^{-1} X/Y$. The implementation of this information in forming a vector (rotating cursor) which rotates through 360° about the optical center mark is shown in Figure 1.

A tangent function is developed through the use of a continuous 360° single-turn potentiometer which has two wiper contacts, mechanically 90° out of phase and can produce sine and cosine functions. The two outputs, sine and cosine, could be operated upon by a four-quadrant divider to produce a tangent function but a two-quadrant divider is the only type available. Therefore it is required to obtain the absolute value of the cosine function, divide the sine function by the absolute cosine function, and by means of a sign identification circuit (polarity selection) produce a tangent function. The zero crossing detector will identify quadrants 2 and 3 which will enable a sign reversal switch in the polarity selection function to obtain the proper sign for the tangent function. In order to inhibit the display of the complement of the vector, the outputs of the zero crossing detector are multiplexed with the vertical sign identification signals generated in the center symmetrical horizontal cursor circuit. This will identify the positive or negative half of the vertical sawtooth and will blank the appropriate 180° out-of-phase vector about the horizontal center mark.

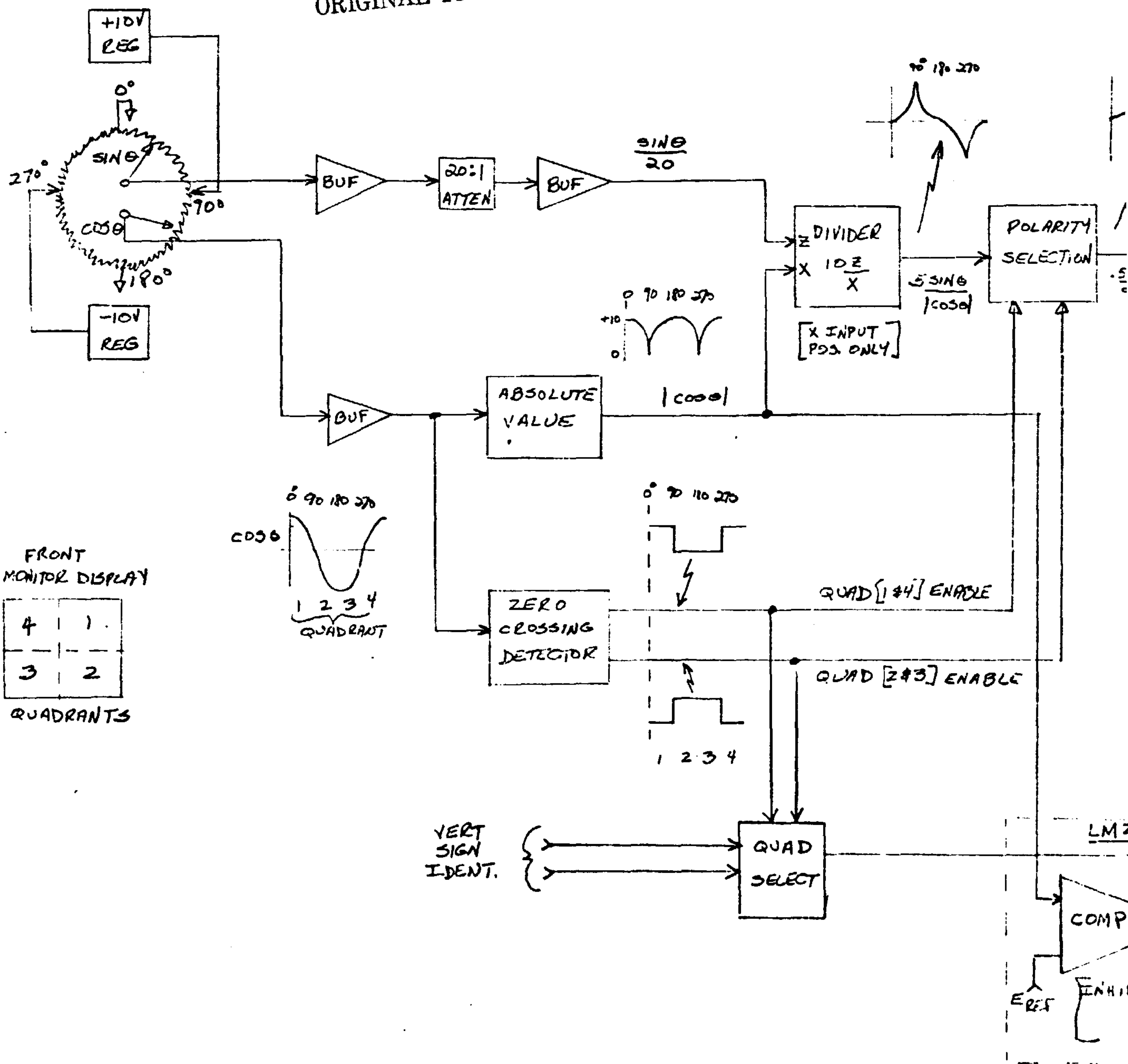
Since a tangent function has a value of infinity at (90°, 270°) and the circuit modules have a supply voltage limitation of $\pm$15 volts dc, it was necessary to normalize the divider

FOLDOUT FRAME 1

FIGURE

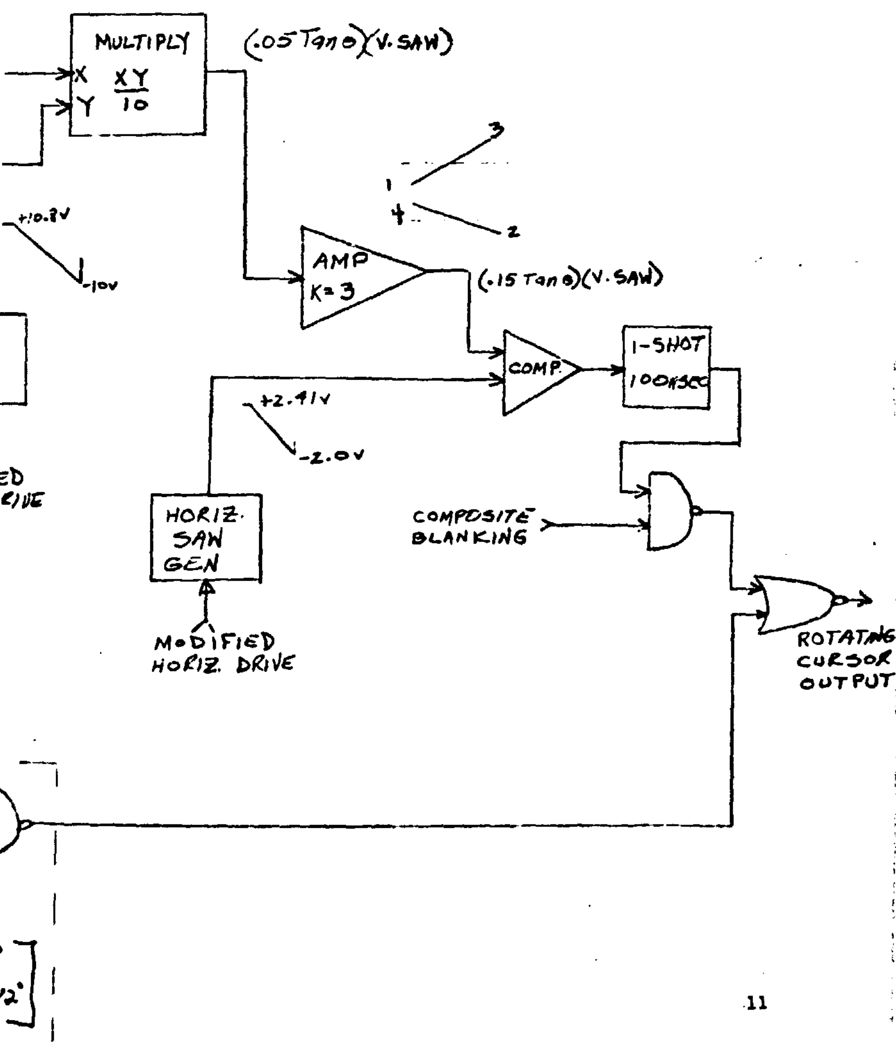
ROTATING VECTOR CURSOR

BLOCK DIAGRAM



OTE: 1. In order to accommodate a tangent function, 1 @ 45° and 20 @ 88° the divider output has been normalized to .5V ⇒ 1 and 10 ⇒ 20.

FOLDOUT FRAME 2



M. Kravitz

output (0.5 volts $\Longrightarrow \tan^{-1} 45° = 1$, 10 volts $\Longrightarrow \tan^{-1} 87.1° = 20$). The vertical ramp is multiplied by the tangent function in the multiply function module. This will produce a ramp whose slope is determined by the wiper location of the sine and cosine potentiometer and provide constant angular progression of the cursor with knob rotation. The output of the amplifier following the multiply module will produce an overall transfer function that will correlate the potentiometer knob position to the vector location on the monitor display.

Comparison of the vertical and horizontal waveforms will produce an output on coincidence which, in turn, triggers a monostable multivibrator of 100 nanosecond duration. Thus, the cursor is composed of a single, 100 nanosecond pulse for each scan line. The pulse is inhibited during the composite blanking intervals and enabled by the multiplexed quadrant and vertical signals.

Centering adjustment of the vertical and horizontal sawtooth generators will initially align the vector about the optical center mark. The sawtooth generators being reset by modified vertical and horizontal drive signals, which are derived in their respective center symmetrical cursor circuits, will permit an adjustment to the crosshair position without cuasing a misalignment of the vector.

3.6 Pan and Tilt Units

3.6.1 Angles and Rates - The pan/tilt units are required to be capable of panning $\pm 90°$ and tilting $\pm 20°$. A variable rate control is desired. The constraints placed upon the vendor were for a 6:1 variation in rate as controlled by the amount of deflection of the joystick. A second constraint, that in the slave mode the payload pan/tilt unit must track the camera pan/tilt unit within five percent. The vendor has caused the coordination of these two units to be controlled by a mutual servo system. Two controls have been added to provide an additional incremental adjustment of pan through $\pm 90°$ and of tilt through $\pm 25°$. The rate of angular change is a function of the rate of change of control position.

Each pan/tilt unit may be operated with separate individual controls.

3.6.2 Angle Indicating Meters - An angle monitoring meter is provided to read both pan and tilt position for each unit. This set of meters is mounted in the rack below the shelf in order that it may not be readily seen by the operator, but watched by an observer.

4.0 PERFORMANCE TESTING

Each unit was tested as part of the assembly to assure that the subsystem performance meets or exceeds that specified above. The results of the testing appears in Section 6.0, Results. For example, the camera-sync generator-monitor combination was operated to establish performance of gray-scale rendition, signal-to-noise ratio as a function of scene illumination, resolution, etc. The unit performance and system performance were ascertained. The performance of the pan/tilt units with camera mounted on one unit and either of the payloads mounted on the second unit was measured. Here maximum and

minimum rates of angular travel and the number of degrees error in the tracking through the specified $\pm 90°$ pan and $\pm 20°$ tilt was measured.

The performance of the cursor as viewed on the TV monitor was measured in its ability to permit accurate setting of line position and separation.

5.0 SIMULATED OPERATION

5.1 General Operation - The complete system with simulated satellite payloads and flood and spotlight illuminators was set up in the laboratory to achieve a pre-delivery assurance that the system was meeting its desired performance.

As stated in Section 1.0 the intended use is to study the effectiveness of electronic and visual aids in determining positional and attitudinal information concerning the relationship of payload to the cargo-servicing spacecraft. From the use of this system payload procedures can be developed for alignment and handling, and the best sequences for both payload retrieval and payload deployment.

In particular, it is possible to measure the amount of pitch and yaw error which can be detected by the TV system as a function of field-of-view and relative distances between spacecraft. The ability to determine payload X and Y displacements can be ascertained. Since payload translations as viewed on the monitor will include some apparent rotational effects as the camera is panned it is necessary to determine the magnitude of this effect and how effectively it can be compensated for by simultaneous panning of the camera and payload.

The tests conducted prior to delivery were designed to provide preliminary and partial answers to the above questions and provide the basis for any pertinent recommendations relating to the operation of the TV system.

5.2 Simulated Linear Motion of the Satellite Model - Analysis - One of the system requirements is to produce on the TV monitor the effect of the satellite model moving in space across the scene area without actually translating the model. This is done by simulating the linear motion of the object by panning and tilting the camera, and simultaneously rotating the object (satellite model). This type of motion would occur if a payload were moved by the manipulating arms across the field-of-view of the camera. This is typical of movement associated with the remote manipulation of a payload from the shuttle to the space station. Such a simulation using the pan/tilt of the camera and model is valuable for training and evaluation purposes.

The geometry of how this simulation may be carried out is shown in Figures 2 and 3. In Figure 2 the object is actually translated to the left a distance X.

The angle β which is the angle generated at the camera lens by the light ray which follows a spot A on the object is defined by the right triangle sides x and d, where d is the distance to the camera from the object plane. For a given translation distance, x, the angle of the camera light ray with the side of the object O was originally α_1, but changes to α_2 as the model is moved into position O".

The amount of the change in angle may be defined by drawing on the diagram a line parallel to line d. The angle γ between this line and the new ray line Γ, thus represents the angular change, and from the geometry of parallel lines can be seen that is equal to angle β.

In Figure 3 the above translation is simulated by panning the camera. To move the object position relative to the field-of-view of the camera lens the camera will need to be panned to the right through an angle equal to β as in Figure 3,

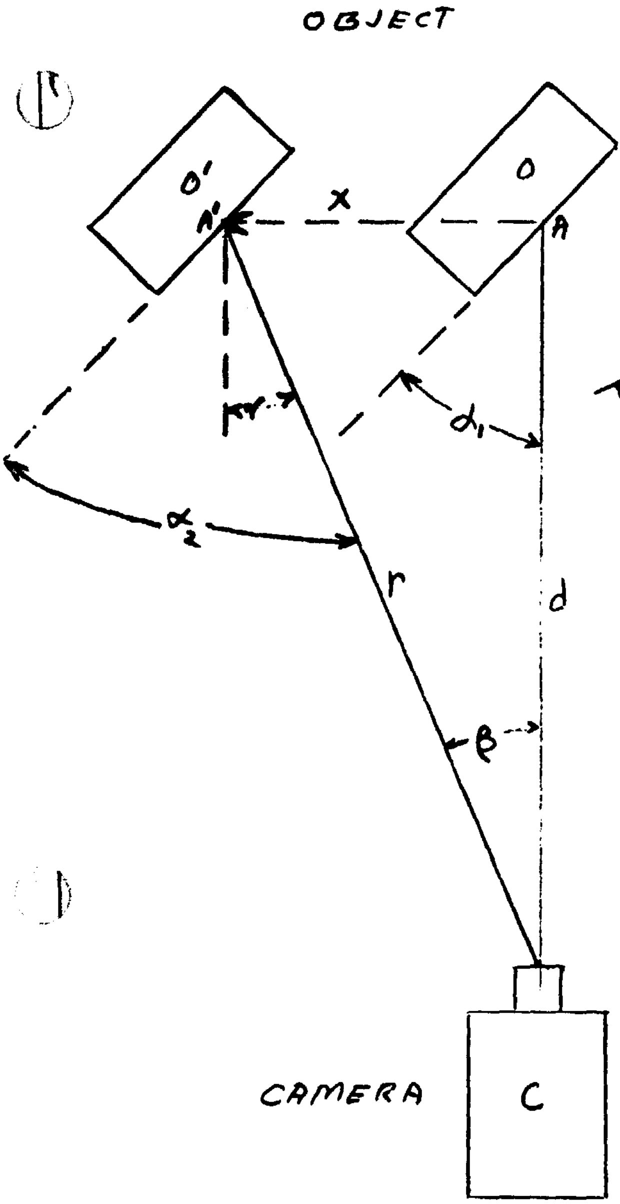


FIGURE 2

DIAGRAM SHOWING ACTUAL MOTION OF OBJECT IN THE OBJECT PLANE

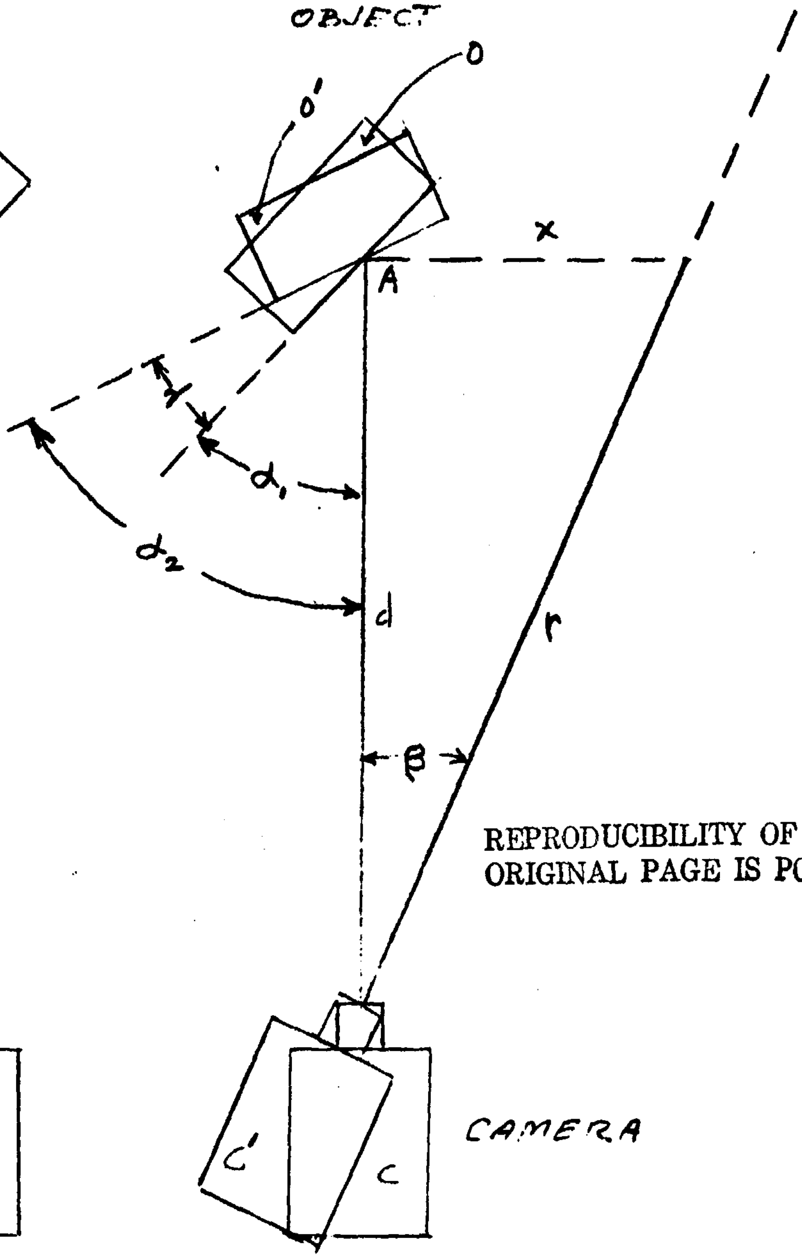


FIGURE 3

DIAGRAM SHOWING SIMULATED MOTION PRODUCED BY PANNING THE CAMERA AND ROTATING THE OBJECT

causing a movement of the image on the monitor from right to left. Lines "d" and "x" will have the same values as in Figure 2. The angle α_1 remained fixed, however, and to one viewing the image this gives the illusion that the object is rotating, since for proper simulation it should equal α_2. The correction of this error may be accomplished by actually rotating the object (satellite model) throught the angle γ, which has been shown to be equal to the pan angle, β. The angle of the ray with the side of the object will now be α_2 as in Figure 2.

Thus to correctly simulate a translation or linear movement of the object along an object plane, it is necessary to rotate the object in unison with the panning of the camera and by an equal angle. This is provided in this equipment by the capability of locking the pan/tilt head of the model to that of the camera. By having the pan/tilt action of the model slaved to that of the camera any combination of horizontal and vertical motion may be simulated.

As can be seen from the diagrams the relationships hold regardless of the lens field-of-view or of the distance from the camera to the object. It is assumed that the distance d is large compared to the distance x, and, d and Γ are nearly equal, otherwise there would be a size change not accounted for.

6.0 RESULTS

6.1 Test Procedure

A procedure was written for evaluating the performance of the individual units (monitor and camera) and the system as a whole. This procedure is structured to show that the basic requirements of the contract are met and to furnish technical data deemed to be useful in the operation of the system. It appears on the following pages numbered 1 thru 7.

Following the test procedure is a summary of the data.

REVISIONS			REV
LTR	DESCRIPTION	DATE	APPROVED

FOR CONTINUATION OF REVISIONS, SEE SHEET

SERIAL NUMBER OF EQUIPMENT UNDER TEST

ORIG. TEST ______ RETEST PER. ______ SQA ______ DATE ______

FIRST MADE FOR	CONTRACT NO.	RCA Corporation ASTRO-ELECTRONICS DIVISION, PRINCETON, NEW JERSEY
USED ON	WRITTEN DATE	TEST PROCEDURE PAYLOAD OPERATION TV SYSTEM
	ENG. DATE	
	PMO DATE	SIZE A · CODE IDENT NO. 49671 · TP-
PROD. AS. DATE		SHEET 1 OF 7

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1.0 CAMERA - MONITOR PERFORMANCE

Set up camera, black and white monitor and sync generator.

1.1 Monitor Performance.- Measure picture quality.

1.1.1 Monitor Resolution.- With pattern generator measure the horizontal resolution and vertical resolution of the monitor.

1.1.2 Monitor Linearity.- With pattern generator measure the amount of geometric distortion in center of raster and in the corners.

1.1.3 Monitor Gray Scale.- With a step generator measure the gray scale of the monitor.

1.1.4 Monitor Synchronization.- Check out the internal sync separator by removing driving sync and use internal sync.

1.2 Camera Performance.- Measure camera performance capability.

1.2.1 Camera Resolution.- Using a test pattern measure limiting resolution using fixed-focus lens. The faceplate illumination shall be set at 5×10^{-2} foot candles. Repeat with zoom lens at focal lengths of 18 mm and 108 mm. This may be observed on the monitor with measurement verified by a line-selector scope on video output.

Using a vertical line pattern measure the MTF at 300 TV lines with a faceplate illumination of 5×10^{-2} foot candles. This should be a minimum of 0.25 MTF. Measure the MTF as above but with a faceplate illumination of 0.1 foot candles. This should be a minimum of 0.3 MTF.

1.2.2 Camera Linearity.- Using a ball-chart pattern, the monitor, and a pattern generator measure the geometric distortion introduced by the camera. Also note the total camera-lens-monitor geometric distortion. This should not exceed 3% but desirably will be 1% or less. Note if any vignetting due to the lens occurs.

1.2.3 Camera Sensitivity and Gray Scale.- Using a step pattern adjust the chart illumination so that the minimum step is lost in the noise. Note value of scene illumination and lens aperture setting. Increase faceplate illumination until the top step of the step pattern begins to saturate. Note value of scene illumination and lens aperture setting.

Vary the average brightness of the test pattern from 1 foot-lambert to 1000 foot-lamberts and adjust lens iris. The iris adjustment and video control in combination should render an appropriately useful output video throughout the range.

1.2.4 Camera Shading.- Using a flatly illuminated blank chart measure the total shading across the picture horizontally and then vertically with the illumination of the faceplate adjusted to give a strong, but unsaturated signal.

The value of shading should not exceed 15% of the black-to-white video over the entire picture area.

Cap the lens and measure the black level shading.

1.2.5 Camera Signal-to-Noise Ratio.- Using a pattern with balck-to-white vertical blocks (or wide bars) measure the signal-to-noise ratio with a faceplate illumination of 0.1 foot candle.

2.0 CURSOR GENERATOR PERFORMANCE

Set up cursor generator feeding video output into the monitor. Continue to operate the camera on a typical scene.

2.1 Individual Brightness Controls.- Operate each of six individual brightness controls. Observe that each cursor output is capable of a full brightness range from complete extinction to full video signal level.

2.2 Horizontal Dual Trace.- Turn up brightness pot and demonstrate that as spread function pot is turned that both horizontal lines move equal distances from the center out to the edge of the picture. Note line width.

2.3 Horizontal Single Trace.- Turn up brightness pot and demonstrate that single trace can be moved from top to bottom of the scanned raster. Note line width.

2.4 Vertical Dual Trace.- Turn up brightness and demonstrate that vertical lines can be moved equidistant from the center (as in 2.1). Note line width.

2.5 Vertical Single Trace.- Turn up brightness pot and demonstrate that single vertical line can be moved from right hand to left hand edge of picture. Note line width.

2.6 Rotatable Single Line.- Turn up brightness pot and rotate vector about the center position through 360°. Increase vector length to extend through the center to the opposite edge of picture raster. Note line width.

2.7 Optical Center Electronic Marking.- Turn up brightness pot and note cross mark at picture center. Note length of crossing lines and width of lines

3.0 PAN/TILT UNIT PERFORMANCE

Set up pan/tilt unit; mount camera and satellite models. Note that it operates with separate controls or with camera head slaved to satellite model control. Note that joystick operation is smooth and that its speed control is continuously variable.

3.1 Speed Control.- Operate pan/tilt functions at minimum speed and measure the time with a stop watch required to pan from -90° to +90° (through 180°). The time should be 360 seconds or more. Operate through 180° at maximum rate. The time should be 60 seconds or less. Operate through ±20° (40° excursion) and note time at both minimum and maximum rates. The times should be 80 seconds or more and 13-1/3 seconds or less, respectively. Operate tilt through ±20° at minimum and maximum rates. Times should be 66-2/3 second or more and 11-1/9 seconds or less. Operate through ±5°. Times should be 16-2/3 second or more and 2.77 second or less, respectively.

3.2 Tracking

3.2.1 Pan.- Adjust the position to be +90° for both units and place in slaved or simultaneous operation. Pan through 180° to -90° position. The error should not exceed 9°. Repeat, -90° to +90°. Measure angles on the driven heads with a protractor.

3.2.2 Tilt.- Set up both units to -20° tilt position. Operate in the simultaneous mode to the +20° position. The error should be less than 2°. Repeat: +20 to -20°.

3.2.3 Pan and Tilt.- Set both units to match at +20° pan and +20° tilt. Operate joystick to enable both pan and tilt and continue to -20° tilt. Note position of heads and compute error. Repeat from -20° pan, -20° tilt moving to +20° tilt.

3.3 Position Measuring Meters.- Set zero adjustments on meters. Use protractor on heads or other methods of measuring angular position. With pan controls move head in 10° increments and take reading of the meters. Draw calibration curve for each pan-position meter. Repeat the process for the tilt function.

4.0 OPERATIONAL PERFORMANCE

4.1 Panning Into a Defined Area.- Set up limits on monitor by defining an area near the center with the cursor generator. Using pan/tilt operation demonstrate degree of ease by which a scene element such as a satellite model may be directed within the defined area. Repeat using corners for defined area.

4.2 Panning Along a Diagonal Line.- Using rotatable cursor, set a line diagonally across the picture. Using combination pan/tilt control, cause the image of a point in the scene to follow the cursor line.

4.3 Translational Mode.- It is possible to simulate the linear translation of the satellite model by the simultaneous panning of the camera and the angular rotation of the satellite model at the same time.

To verify this operation, connect the camera pan/tilt head and that of the satellite model to a common joystick control. Normally the satellite model pan/tilt head will be the slave and the camera unit will be the master.

Pan the camera, causing the satellite model image to travel across the scanned raster of the monitor. Make a subjective evaluation under three conditions.

1. Joint servo control of camera and model for pan/tilt.

2. Camera pan/tilt active; satellite pan/tilt inactive.

3. Pan (or tilt) of model separately controlled.

Note if condition one satisfactorily gives the appearance of a pure translational motion.

Note if condition two gives appearance of the satellite model actually rotating even though it is remaining fixed.

Note the effects of over-compensation and under-compensation while panning the two units and adding offset angle by manually manipulating the offset controls.

To over-compensate pan (or tilt) the satellite model more rapidly. To under-compensate pan (or tilt) the satellite model less rapidly.

6.2 Test Data Summary - The results of conducting tests specified in the Test Procedure are summarized in the following paragraphs. A copy of the log data including polaroid pictures is being sent to the Technical Monitor under separate cover.

Test Procedure Item 1.1.1 Monitor Resolution: The limiting resolution of the monitor was measured to be well above the limiting resolution of the camera at 625 TV lines.

TP 1.1.2 Monitor Linearity - In most areas of the raster the monitor linearity was less than $\pm 1\%$. Along the right hand of the raster, in the upper left corner, and in the lower left the error reached $\pm 2\%$.

TP 1.1.3 Monitor Gray Scale - The ten linear steps generated by a Tektronix Test Signal Generator were reproduced by the monitor and all steps were distinguishable.

TP 1.2.1 Camera Resolution - The limiting resolution of the camera was measured at 625 TV lines. The MTF was measured at 5×10^{-2} foot-candles on the faceplate and found to be 0.30 at 300 TV lines when using the 35 mm fixed-focus lens. It was also measured using the zoom lens and found to be 0.26 at 18 mm focal length and 0.28 at 108 mm focal length.

At 0.1 foot-candle faceplate illumination the MTF at 300 TV lines was 0.35, fixed focus; 0.28 with the zoom lens. The goal was 0.25 at 0.05 foot-candles which was met, and 0.30 at 0.1 foot-candle, which was not quite met.

TP 1.2.2 Camera Linearity - For most of the raster area the camera linearity was 1%. The top center and lower left corner were measured to be 2% error.

TP 1.2.3 Camera Sensitivity and Gray Scale - When using the Canon zoom lens the range of brightness for useful output was measured at 1333. The video gain and lens aperture were both varied to achieve this value. Using a 9-step gray scale pattern all the steps could be readily distinguished.

TP 1.2.4 Camera Shading - The camera shading for white signal varied from 4% to 12% for various parts of the raster. This bettered the requirement of less than 15%. For a lens-capped condition the horizontal and vertical shading was only 1%.

TP 1.2.5 Camera Signal-to-Noise Ratio - With a faceplate illumination of 0.1 foot-candle the signal-to-noise ratio was 44.3 dB.

TP 2.0 CURSOR GENERATOR PERFORMANCE

The horizontal dual and single lines, and the horizontal and dual vertical lines behaved as desired. The line width was adjusted to 1 TV line space, and the line length for the center marker was 5% of picture height. The rotating cursor can be rotated through 360° about the center and behaves as planned.

TP 3.0 PAN/TILT PERFORMANCE

TP 3.1 Speed Control - In the pan direction the joystick control permits a speed change of from 0.3 to 6.34 degrees per second and in the tilt direction the variation is between 0.5 and 5.55 degrees per second.

TP 3.2 Tracking - In both pan and tilt directions the tracking accuracy between the master and slave is not over ±1% error.

TP 3.3 Position Indicating Meters - The meters have been calibrated and calibration charts will be furnished to the Technical Monitor. The meter scale factor is not linear and may give direct reading with errors a high as 40° in pan and 4° in tilt. It is suggested that the calibration curves be used when using the meters.

TP 4.0 OPERATIONAL PERFORMANCE

The results of this procedure are subjective. The following comments will summarize operation reaction.

TP 4.1 - TP 4.2 In these special panning exercises the manipulation of the camera pointing using the pan/tilt controls was easy and natural.

TP 4.3 The simulation of linear translation was done by the simultaneous manipulation of the camera and the satellite payload model.

As shown by geometric analysis in Section 5.2, the correct simulation of linear translation of the satellite model is achieved by panning or tilting the satellite model and the camera at the same rate and through the same angle. The two pan/tilt units are servoed together for this purpose. A subjective test was conducted to verify the validity of this simulation. The effect was verified, but to the observer not alerted to the facts of the analysis, the image motion produced by only panning the camera does not produce a feeling of error in the simulation. However, when they are panned together it becomes quite apparent that a superior simulation is produced. For instance, when looking nearly end-on at the horizontal cylinder model as the camera is panned and the

model is rotated the camera appears to look first at the end and one side, then the end with no sides visible, and finally at the end with the other side visible, correctly depicting the conditions of lateral movement of the model.

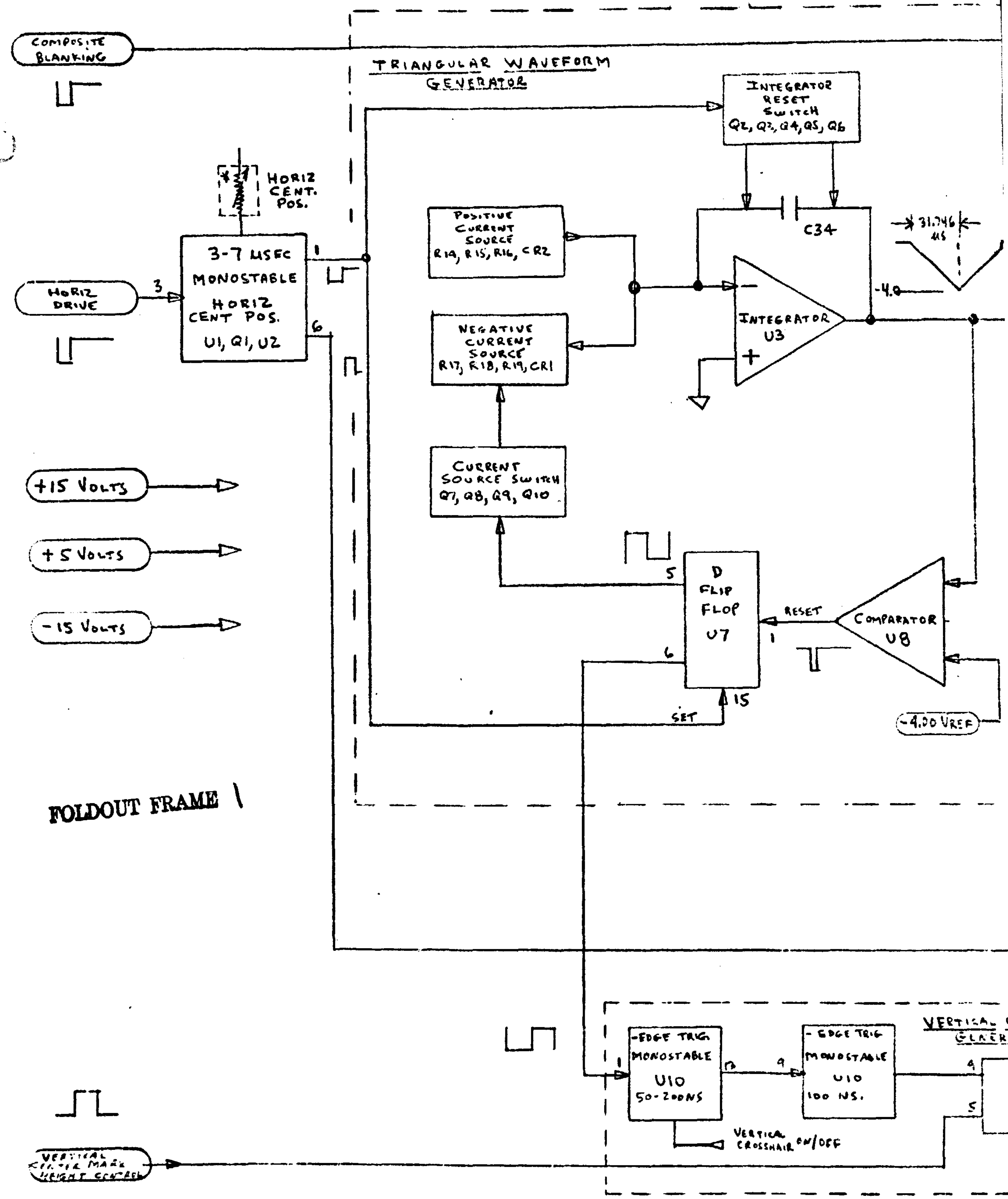
TP 4.4 Simulated Loading Maneuver - A possible payload - satellite - camera configuration is to have the camera look from one side of the payload bay door across the opening. The satellite payload model needs to be aligned accurately parallel to the doorway and with a few inches clearance at the fore and aft ends.

An exercise to ascertain how well this can be done using the system was carried out.

The technique developed by the NASA Technical Monitor is to align the payload sides to point to a vanishing point on the camera optical center line as pictured on the TV monitor.

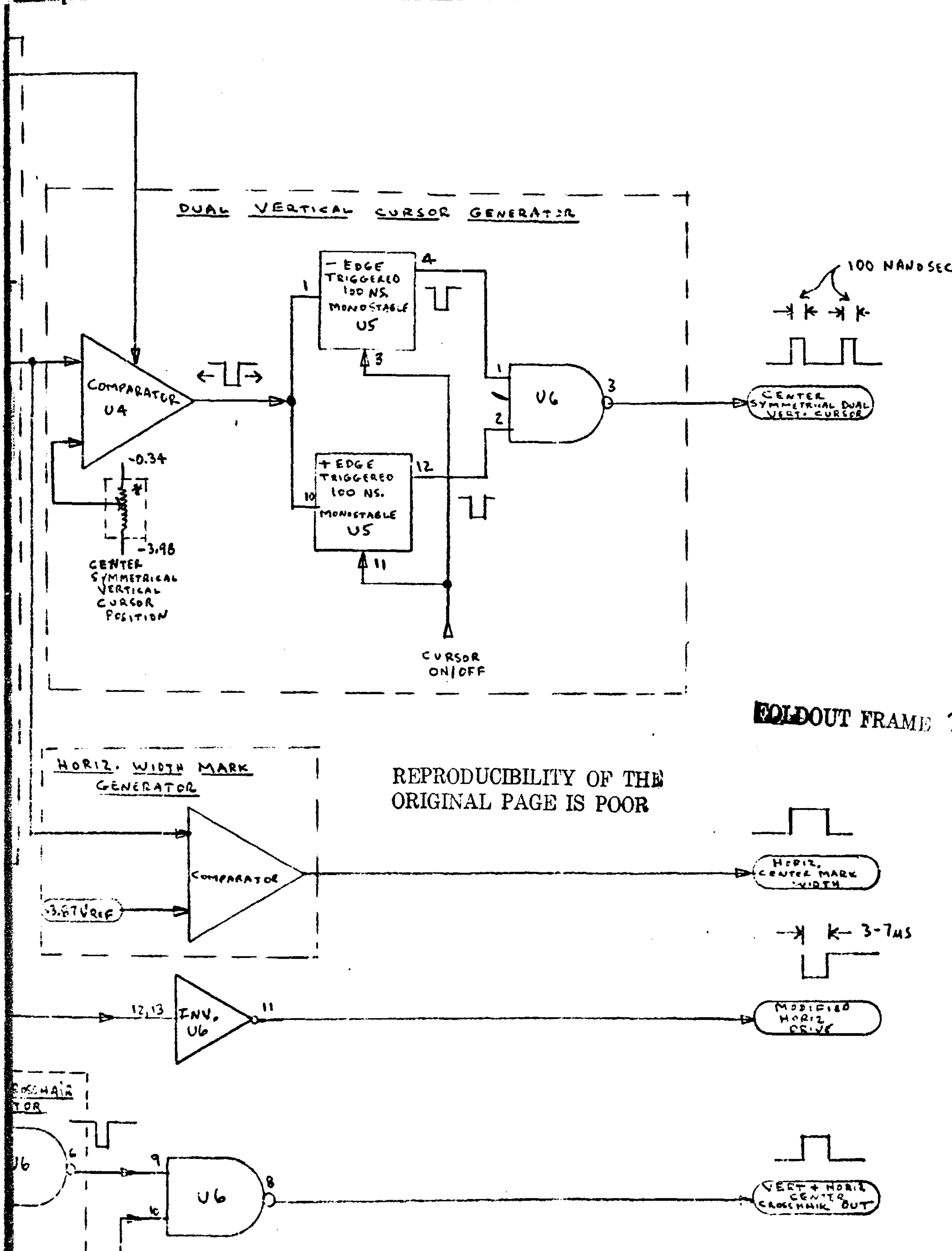
By carrying out this procedure the payload model was aligned parallel to the bay door within a few inches deviation.

7.0 CIRCUIT DIAGRAMS



FOLDOUT FRAME 1

* FRONT PANEL CONTROL



FOLDOUT FRAME 2

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

Figure 4

CENTER SYMMETRICAL DUAL VERTICAL CURSOR BLOCK DIAGRAM

F.G. HUBIT

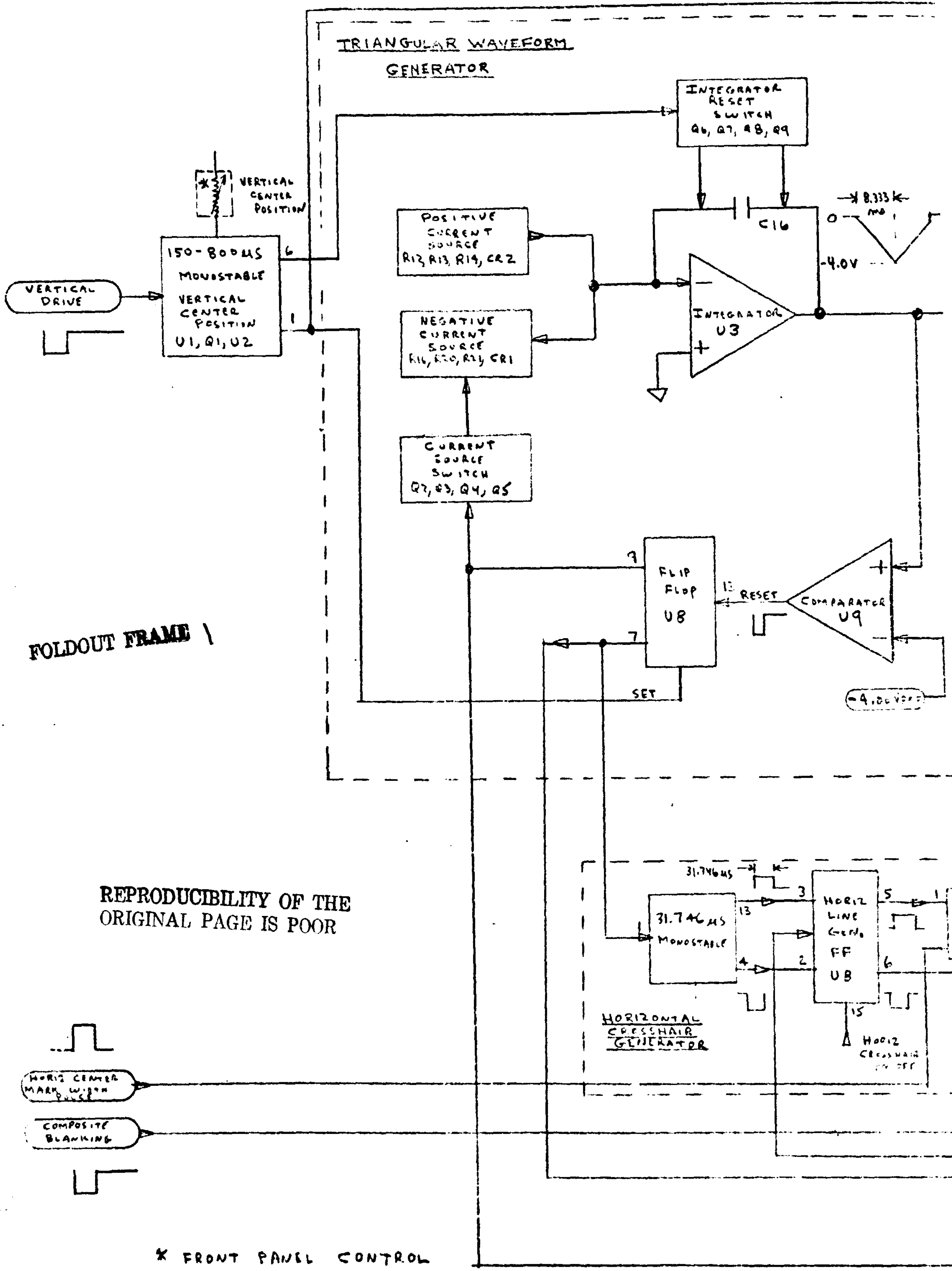
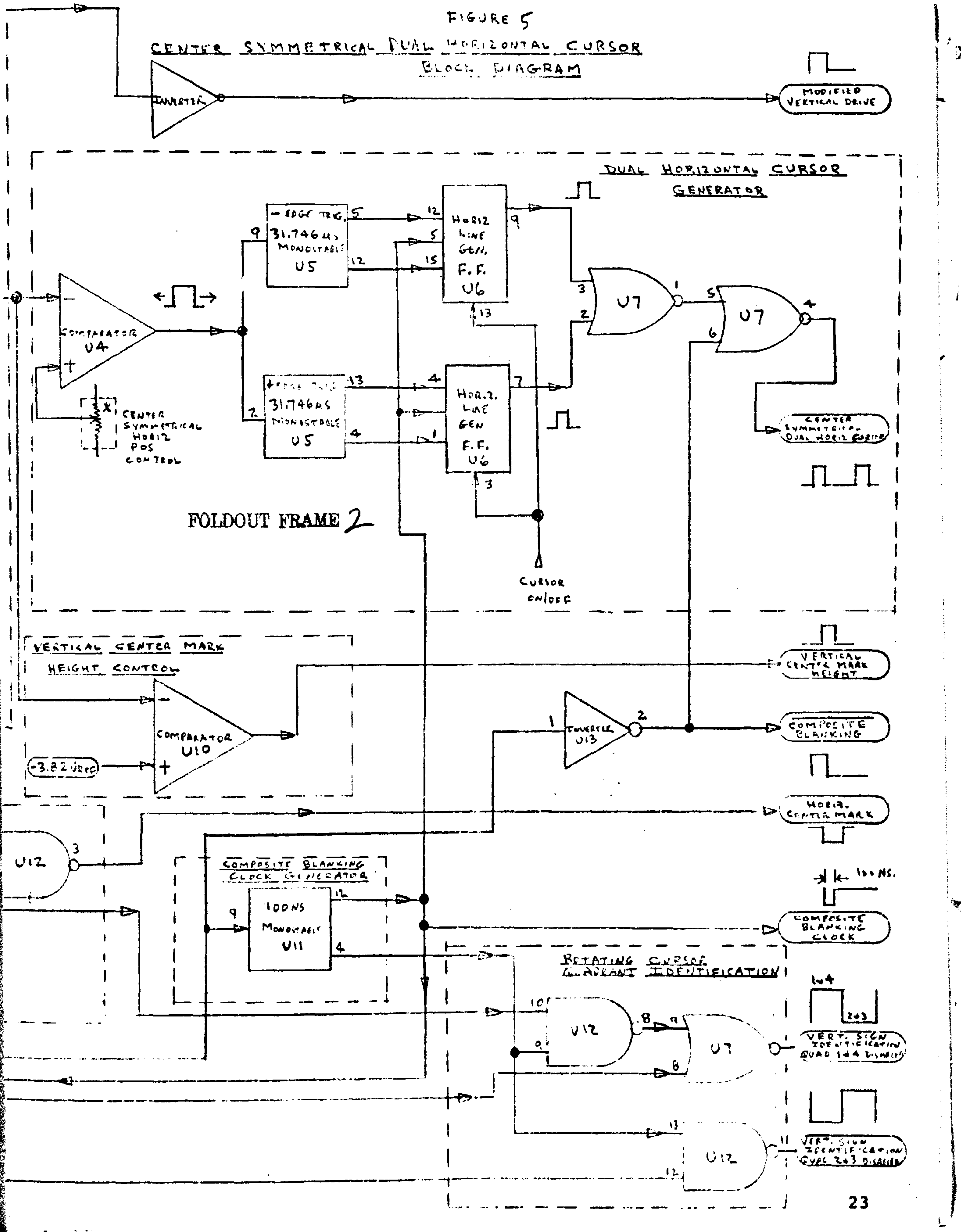
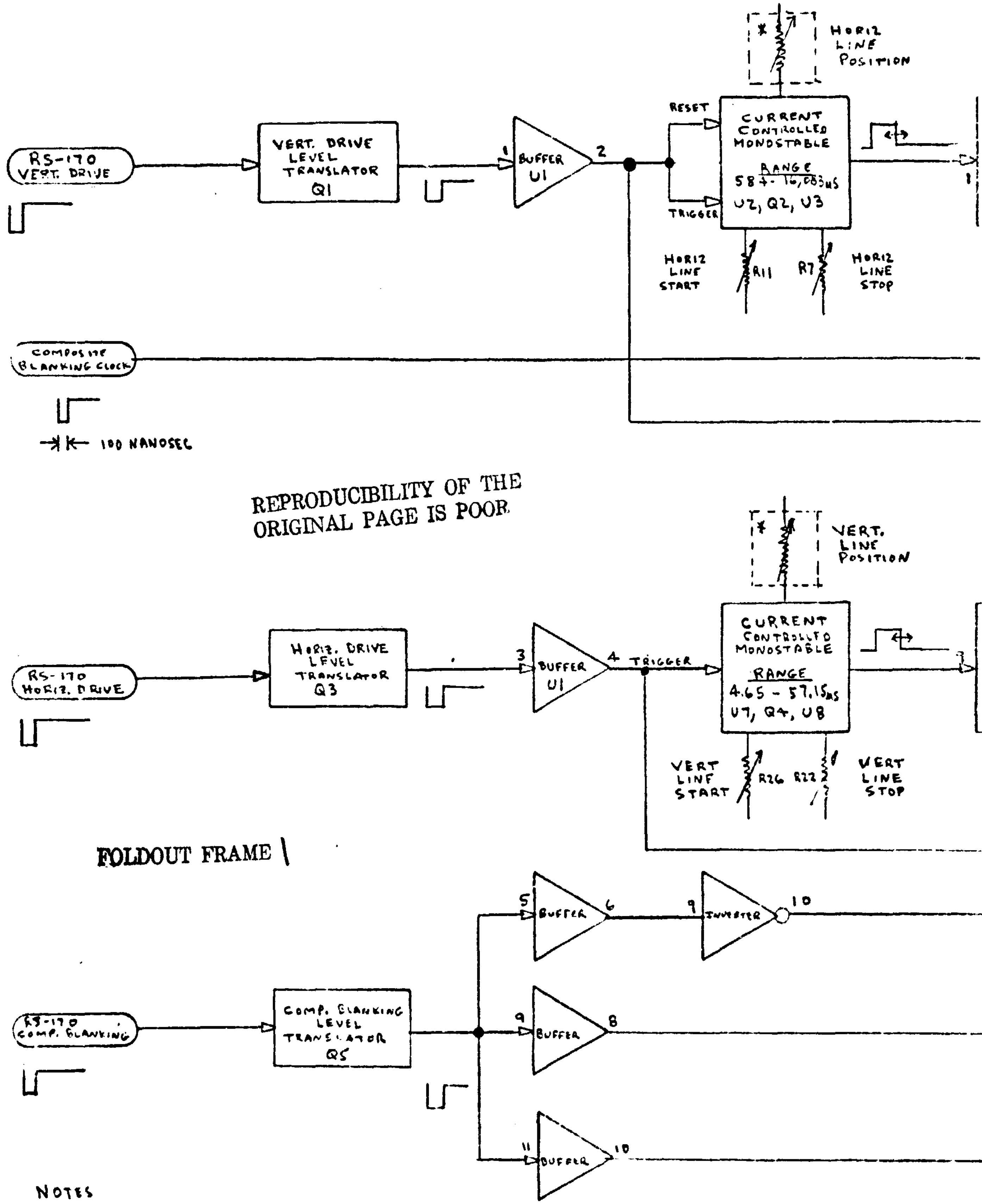

TRIANGULAR WAVEFORM GENERATOR
INTEGRATOR RESET SWITCH Q6, Q7, Q8, Q9
C16
8.333 ms
0
-4.0V
VERTICAL CENTER POSITION
150-800 μs MONOSTABLE VERTICAL CENTER POSITION U1, Q1, U2
VERTICAL DRIVE
POSITIVE CURRENT SOURCE R12, R13, R14, CR2
NEGATIVE CURRENT SOURCE R16, R20, R21, CR1
INTEGRATOR U3
CURRENT SOURCE SWITCH Q2, Q3, Q4, Q5
FLIP FLOP U8
RESET
SET
COMPARATOR U9
HORIZ CENTER MARK WIDTH PULSE
COMPOSITE BLANKING
31.746 μs
31.746 μs MONOSTABLE
HORIZ LINE GEN. FF U8
HORIZONTAL CROSSHAIR GENERATOR
HORIZ CROSSHAIR ON OFF
* FRONT PANEL CONTROL

FIGURE 5

CENTER SYMMETRICAL DUAL HORIZONTAL CURSOR BLOCK DIAGRAM





REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

FOLDOUT FRAME 1

NOTES

* FRONT PANEL CONTROL

V = 16,667 μSEC

H = 63.5 μSEC

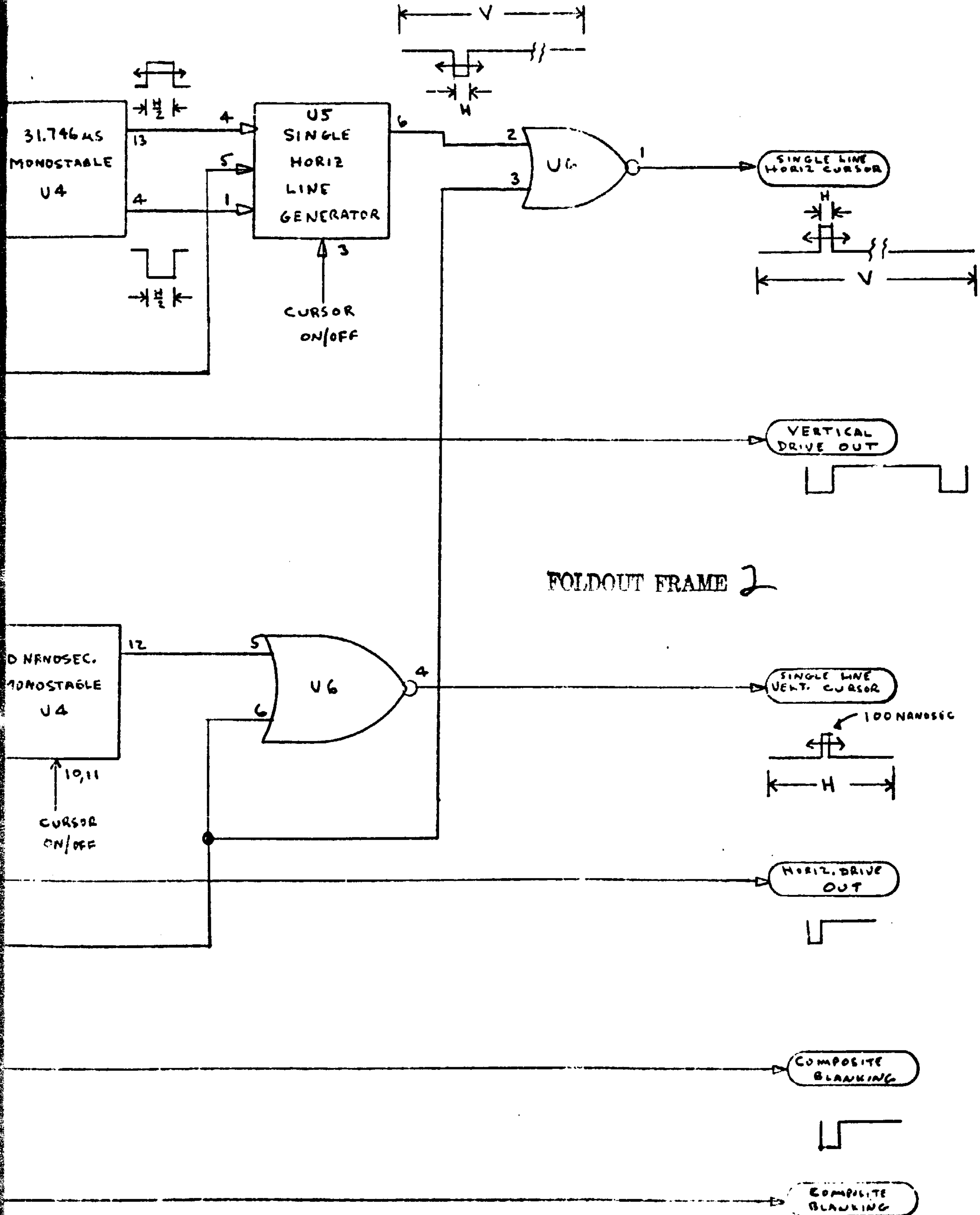
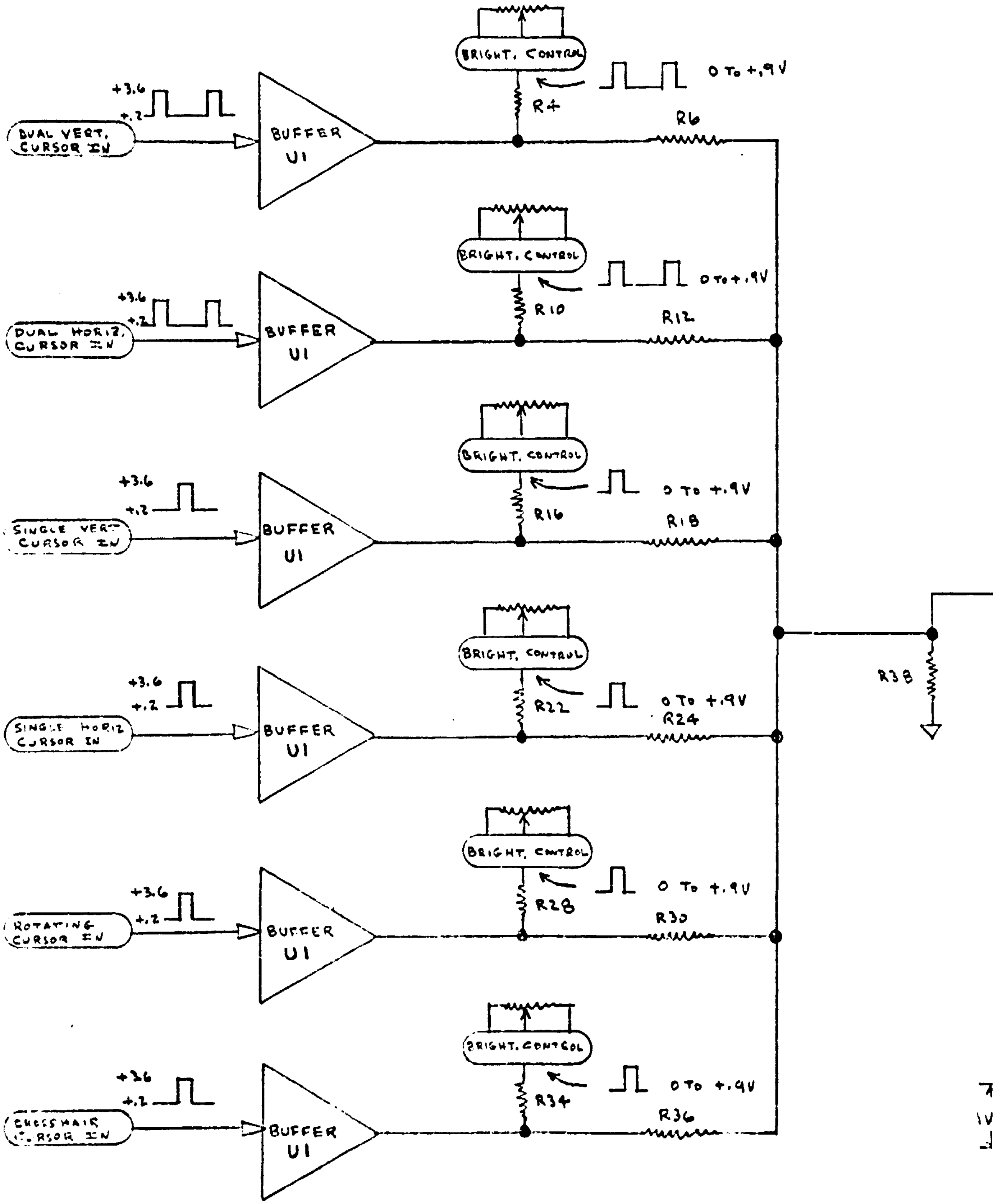


FIGURE 6

BLOCK DIAGRAM
SINGLE VERT. + HORIZ.
LINE CURSOR

F.G. HOBIT



FOLDOUT FRAME 1

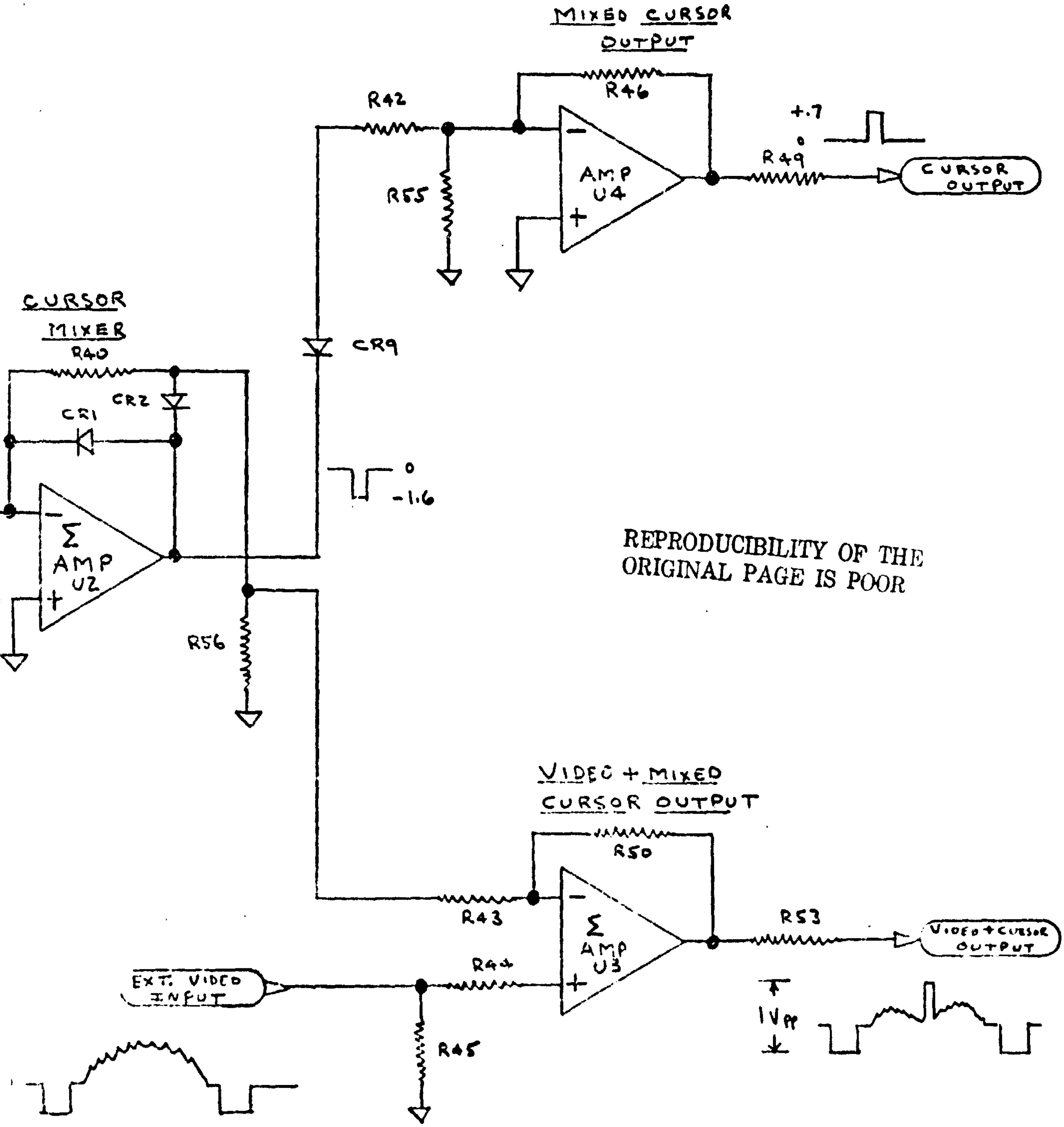
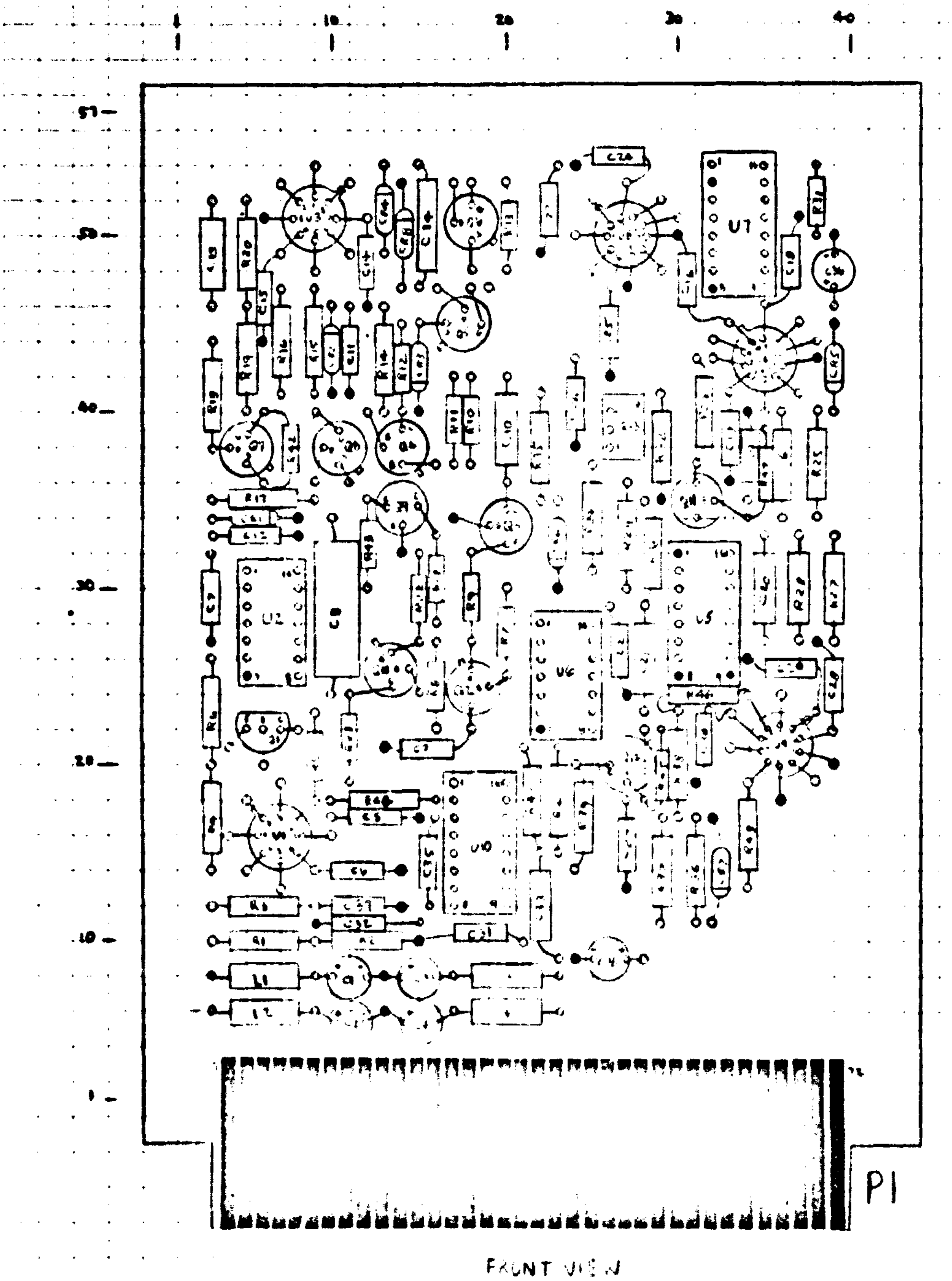


FIGURE 7

FOLDOUT FRAME 2

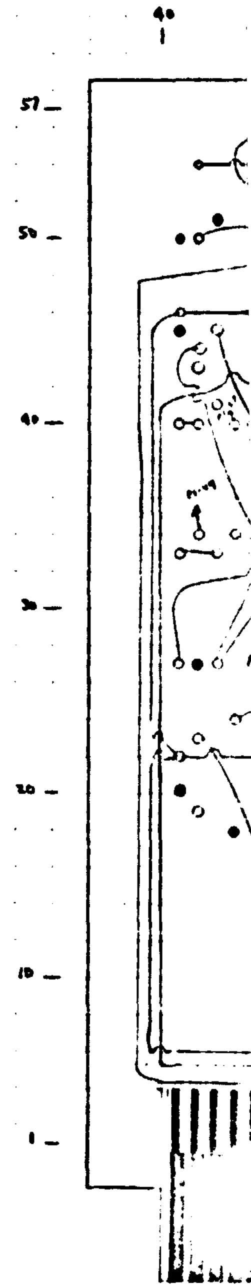
BLOCK DIAGRAM CURSOR MIXER, CURSOR OUTPUT, MIXED CURSOR + VIDEO OUTPUT



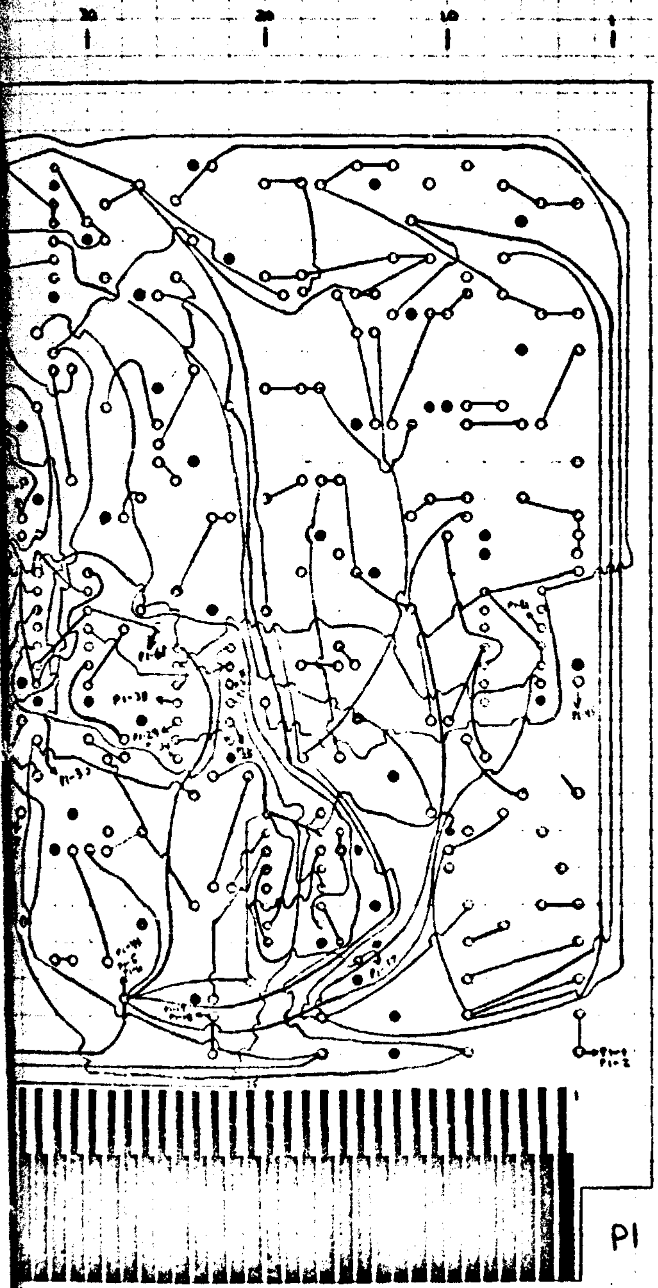
NOTES:

1. ● DENOTES SOLDER CONNECTION TO GROUND PLANE
2. ALL I.C.'S SHOWN TOP VIEW
3. ALL TRANSISTORS SHOWN BOTTOM VIEW

FOLDOUT FRAME



SYM	ZONE	REVISIONS DESCRIPTION	DATE	APPROVED



REAR VIEW

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

FOLDOUT FRAME 2

ITEM NO	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION

LIST OF MATERIALS

CONTRACT NO. [illegible] 14-617

COMMODITY CODE

DRAWN DATE

CHECKED DATE

DESIGN ACTIVITY APPD. DATE

RADIO CORPORATION OF AMERICA
CAMDEN, N. J.
ASTRO ELECTRONICS DIVISION PRINCETON, N.J. PLANT

ASSEMBLY
CENTER SYMMETRICAL DUAL
VERTICAL CURSOR
BOARD A1

CODE IDENT NO 49671 SIZE D SK 2288693

SCALE 2:1 WEIGHT SHEET

DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON FINISHED DIMENSIONS UNLESS OTHERWISE SPECIFIED

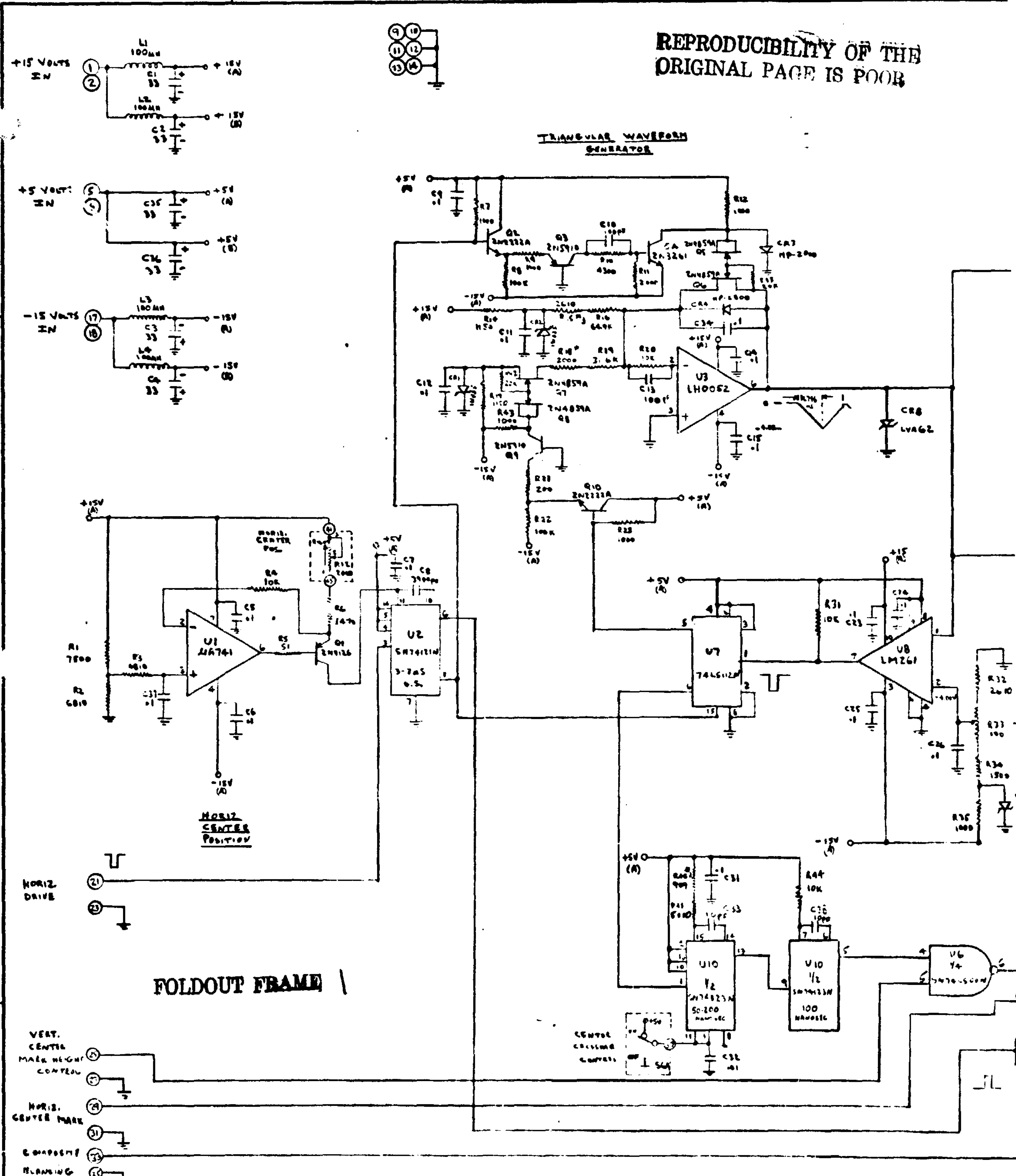
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .005
6 TO 24	± .04	± .010
ABOVE 24	± .06	± .015

ANGULAR DIMENSIONS ± 1/2°

SEE RCA PURCH SPEC FOR STOCK TOL

FIRST MADE FOR	
NEXT ASS'Y	USED ON

ALL EXTERNAL THREADS TO BE CLASS 2A BEFORE PLATING AND CLASS 2 AFTER PLATING. ALL INTERNAL THREADS TO BE CLASS 2B UNLESS OTHERWISE SPECIFIED.



FOLDOUT FRAME

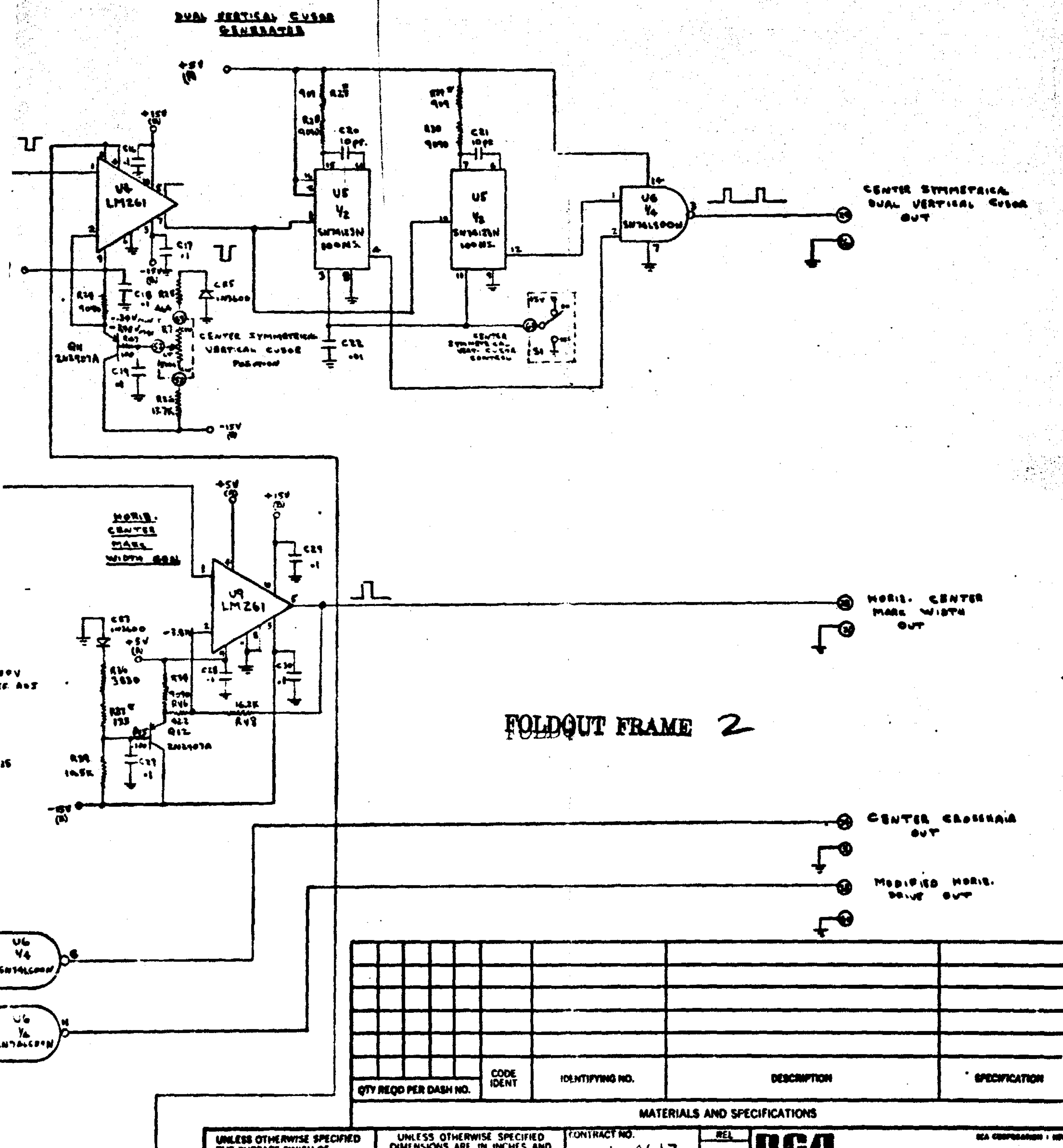
NOTES:

1. ALL RESISTORS ARE IN OHMS.
2. ALL CAPACITORS ARE IN MICROFARADS.
3. $*_1$ NOMINAL VALUE 909 OHMS, ADJUST FOR 100 NS. PULSE WIDTH @ 50% POINTS
4. $*_2$ NOMINAL VALUE 909 OHMS, ADJUST TO CENTER VERTICAL CROSSHAIR WITHIN DUAL VERT. LINE
5. $*_3$ ADJUST SO THAT MOST NEGATIVE POINT ON WAVEFORM IS −4.0 VOLTS
6. $*_4$ ADJUST SO THAT POSITIVE SLOPE IS SAME AS NEGATIVE SLOPE OF TRIANGULAR WAVE.

4	3	2	1

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED



FOLDOUT FRAME 2

QTY REQD PER DASH NO.	CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125 PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

NEXT ASSY	USED ON
FIRST APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS ± 1/2°

RCA COMMODITY CODE:

CONTRACT NO. 14617 REL

DRAWN HUBIT DATE

CHECKED DATE

DESIGN ACTIVITY APPD. M. Zravitz DATE 3/12/76

RCA RCA CORPORATION NEW YORK, NY

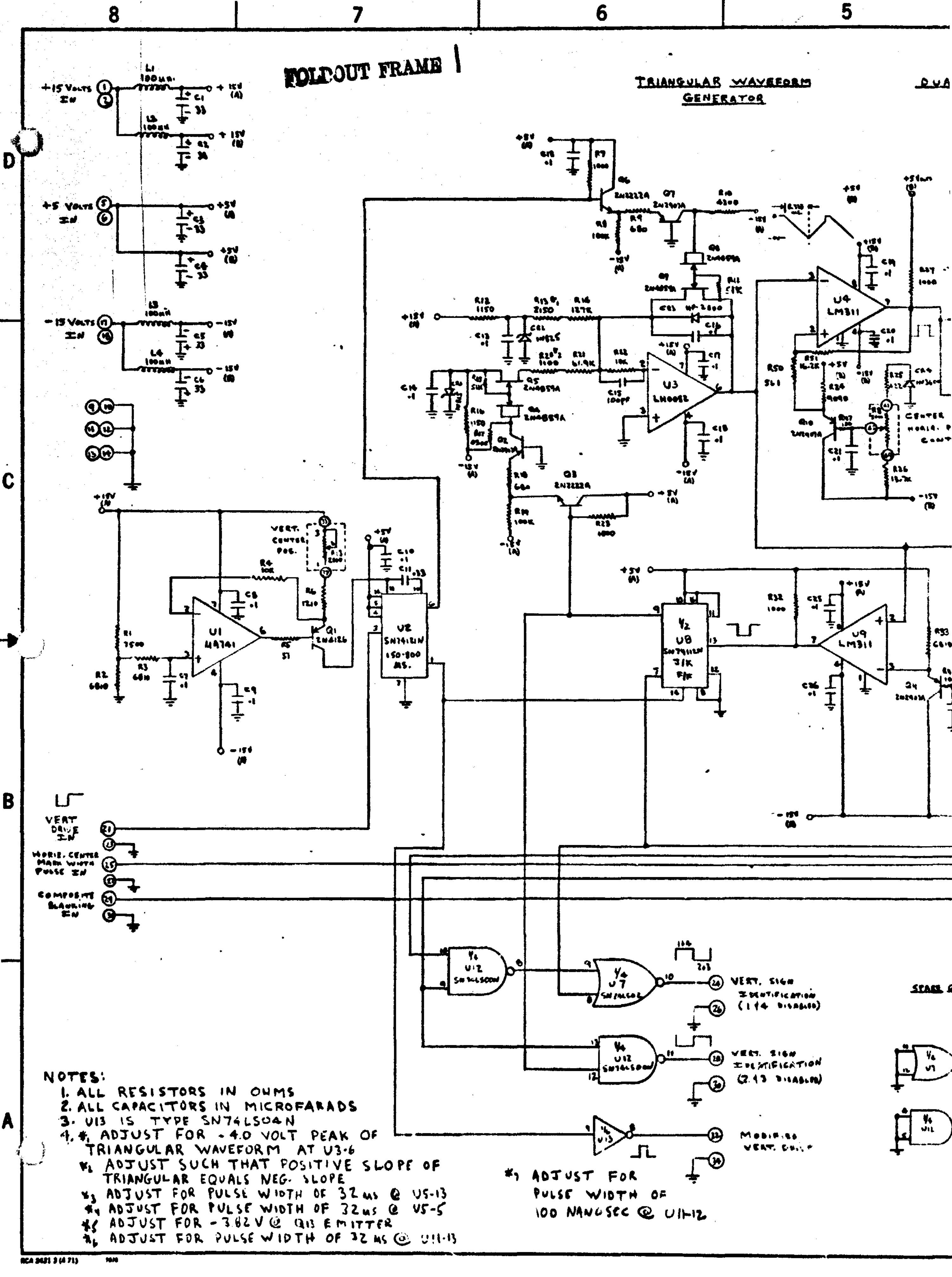
ASTRO ELECTRONICS DIVISION, PRINCETON, N.J.

SCHEMATIC

CENTER SYMMETRICAL DUAL VERTICAL CURSOR - BD. A1

SIZE	CODE IDENT NO.	
D	49671	SK2288694

SCALE SHEET 1 OF 1

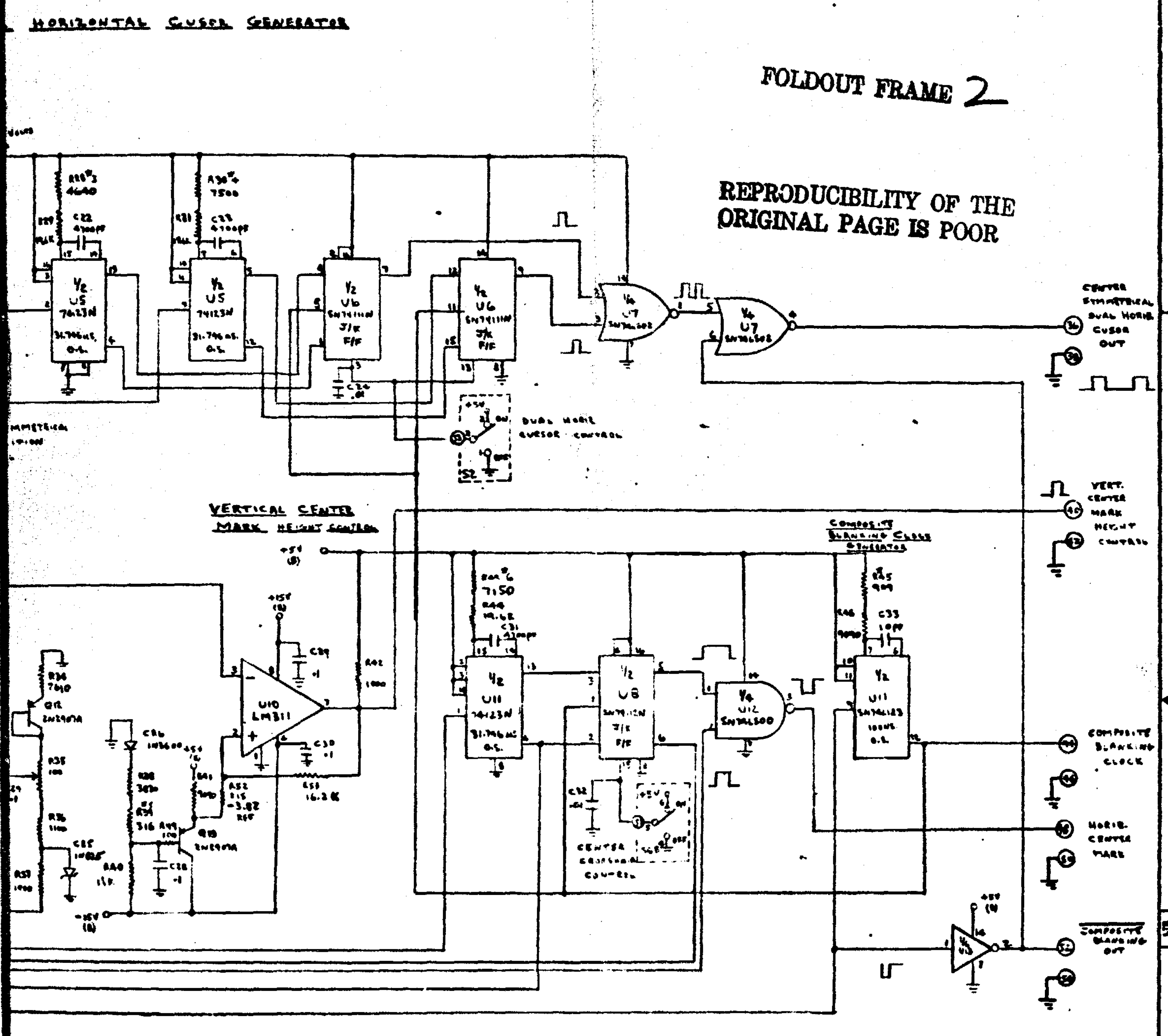

FOLDOUT FRAME 1
TRIANGULAR WAVEFORM GENERATOR
+15 VOLTS IN
+5 VOLTS IN
-15 VOLTS IN
VERT. CENTER. POS.
VERT DRIVE IN
HORIZ. CENTER MARK WIDTH PULSE IN
COMPOSITE BLANKING IN
VERT. SIGN IDENTIFICATION (1.14 DISABLED)
VERT. SIGN IDENTIFICATION (2.13 DISABLED)
MODIFIED VERT. DRIVE
CENTER HORIZ. POS. CONT.
NOTES:
1. ALL RESISTORS IN OHMS
2. ALL CAPACITORS IN MICROFARADS
3. U13 IS TYPE SN74LS04N
4. *1 ADJUST FOR -4.0 VOLT PEAK OF TRIANGULAR WAVEFORM AT U3-6
*2 ADJUST SUCH THAT POSITIVE SLOPE OF TRIANGULAR EQUALS NEG. SLOPE
*3 ADJUST FOR PULSE WIDTH OF 32 ms @ U5-13
*4 ADJUST FOR PULSE WIDTH OF 32 ms @ U5-5
*5 ADJUST FOR -3.82V @ Q13 EMITTER
*6 ADJUST FOR PULSE WIDTH OF 32 ms @ U11-13
*7 ADJUST FOR PULSE WIDTH OF 100 NANOSEC @ U11-12

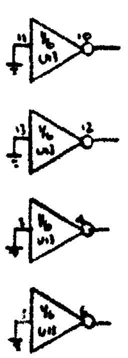
4	3	2	1

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

FOLDOUT FRAME 2

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR





QTY REQD PER DASH NO.	CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

NEXT ASSY	USED ON
FIRST APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS ± ½

RCA COMMODITY CODE:

CONTRACT NO. 14617 | REL

DRAWN J. J. JB T | DATE

CHECKED | DATE

DESIGN ACTIVITY APPD. M. Krawitz | DATE 2/12/76

RCA — RCA CORPORATION NEW YORK, NY

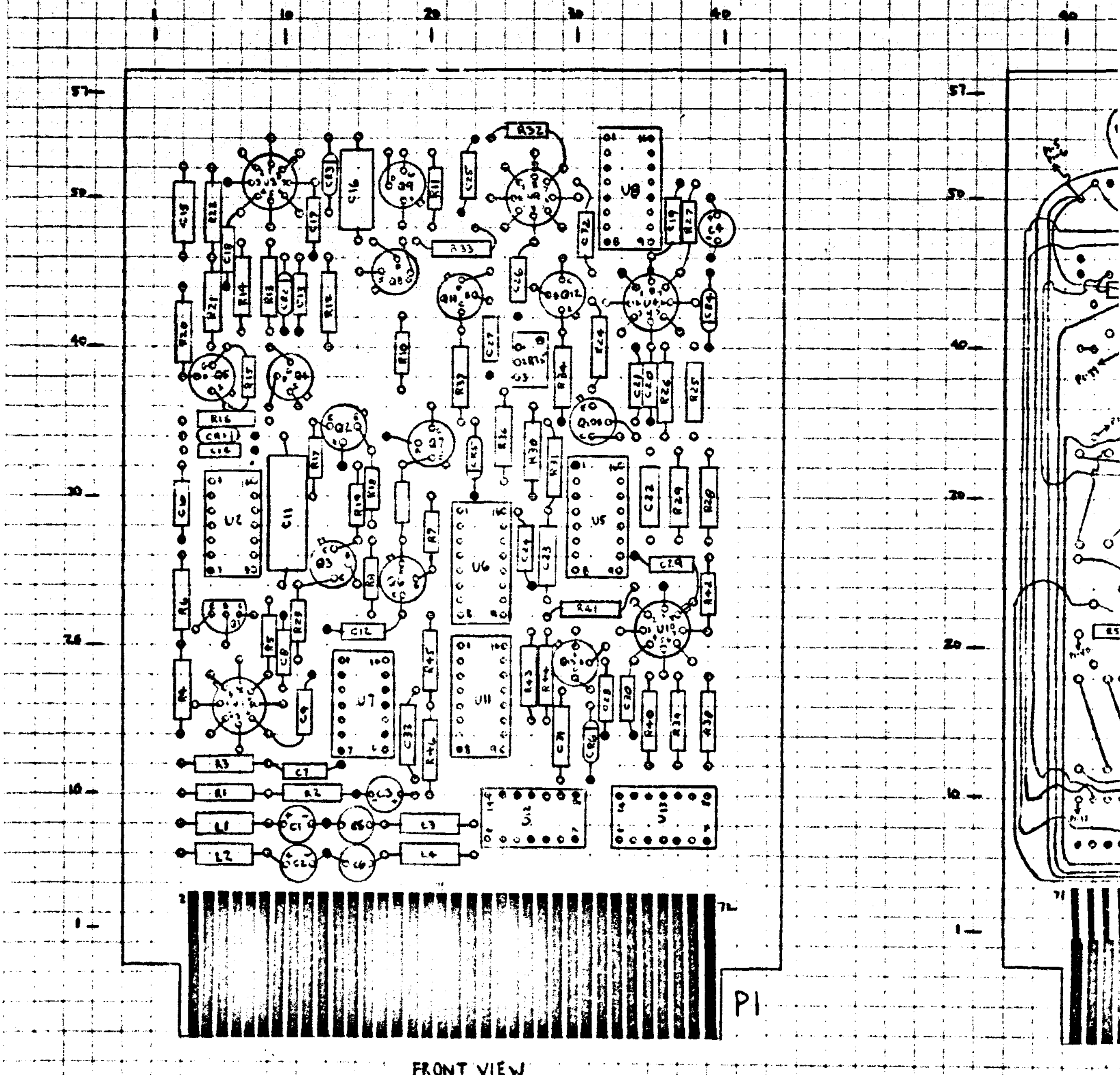
GOVERNMENT ELECTRONICS DIVISION, PRINCETON, N.J. | PLANT

SCHEMATIC CENTER SYMMETRICAL DUAL HORIZONTAL CURSOR BD. A2

SIZE	CODE IDENT NO.	
D	49671	SK2288695

SCALE | SHEET 1 OF 1

FOLDOUT FRAME 1

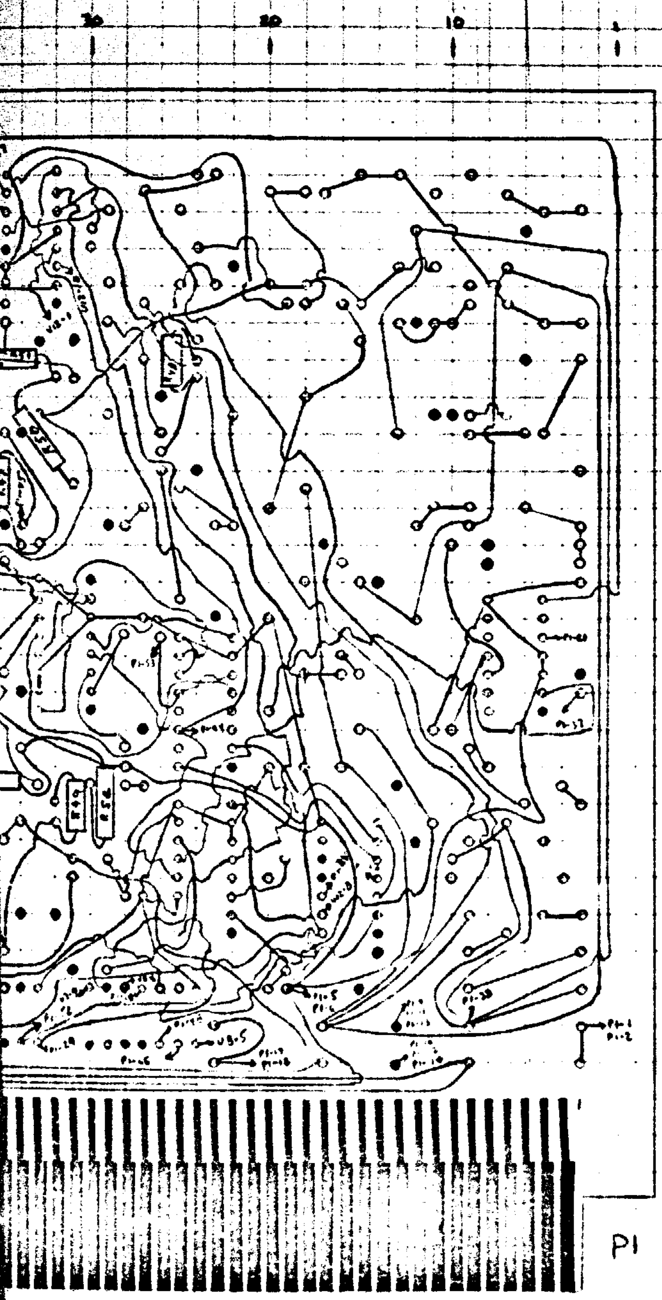


NOTES:

1. ● DENOTES SOLDER CONNECTION TO GROUND PLANE
2. ALL I.C.'S SHOWN TOP VIEW
3. ALL TRANSISTORS SHOWN BOTTOM VIEW
4. GROUND PINS 23, 27, 31, 26, 30, 34, 38, 42, 46, 50, 54

REVISIONS				
SYM	ZONE	DESCRIPTION	DATE	APPROVED

FOLDOUT FRAME 2



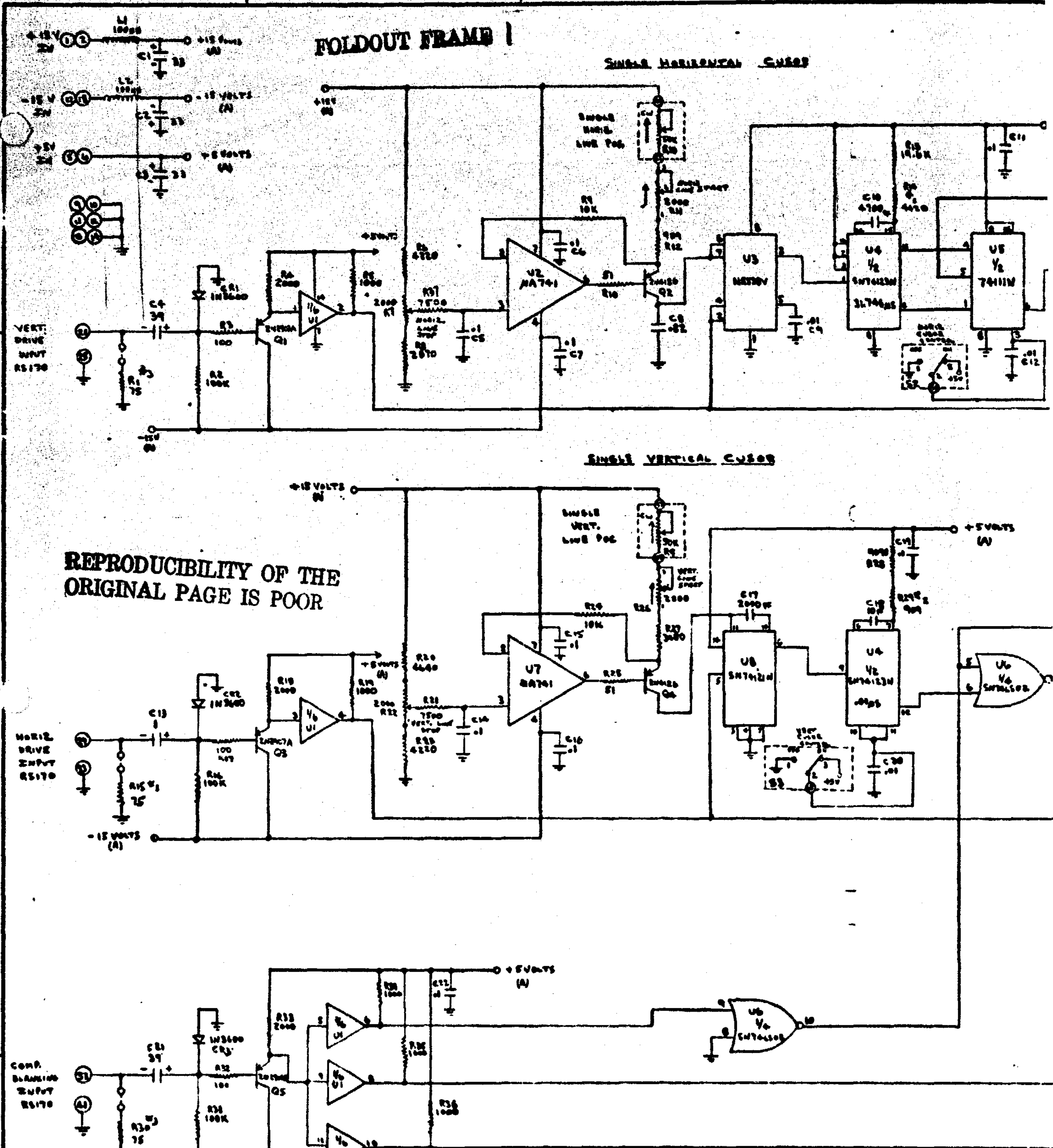
REAR VIEW

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

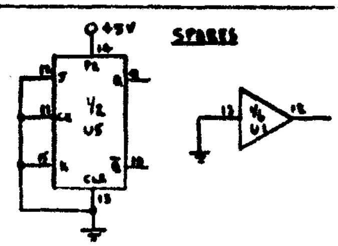
CONTRACT NO. NAS9-14617	RADIO CORPORATION OF AMERICA CAMDEN, N. J. PLANT
COMMODITY CODE	
DRAWN F. J. HUBIT DATE	ASSEMBLY CENTER SYMMETRICAL DUAL HORIZONTAL CURSOR BOARD A2
CHECKED DATE	
DESIGN ACTIVITY APPD. DATE 2-12-76	CODE IDENT NO 49671 SIZE D SK 2288696
	SCALE WEIGHT SHEET 1 OF 1

FIRST MADE FOR	
NEXT ASS'Y	USED ON

FOLDOUT FRAME 1



REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR



A

NOTES:

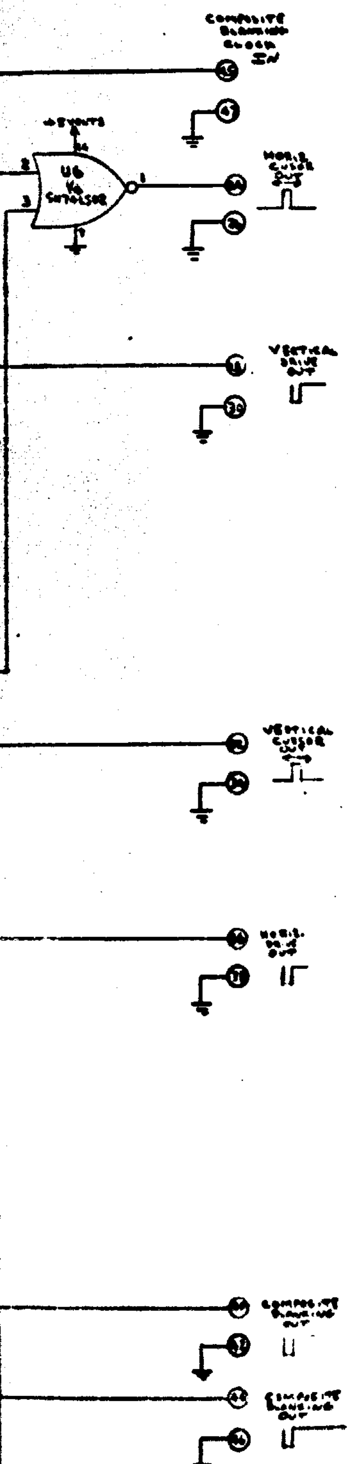
1. ALL RESISTORS IN OHMS
2. ALL CAPACITORS IN MICROFARADS
3. U1 IS TYPE SN7407N
4. *1 ADJUST PULSE WIDTH TO 32 μs
5. *2 ADJUST PULSE WIDTH TO .01 MS.
6. *3 FOR 75 OHM TERMINATION ADD JUMPERS SHOWN IN DOTTED LINES
7. GROUND PINS 26, 30, 34, 38, 42, 46, 47

4	3	2	1

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED

FOLDOUT FRAME 2



QTY REQD PER DASH NO.	CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING ✓ PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

THIS DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

NEXT ASSY	USED ON
FIRST APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS ± ½

RCA COMMODITY CODE

CONTRACT NO. 4617 | REL
DRAWN | DATE
CHECKED | DATE
DESIGN ACTIVITY APPD. | DATE

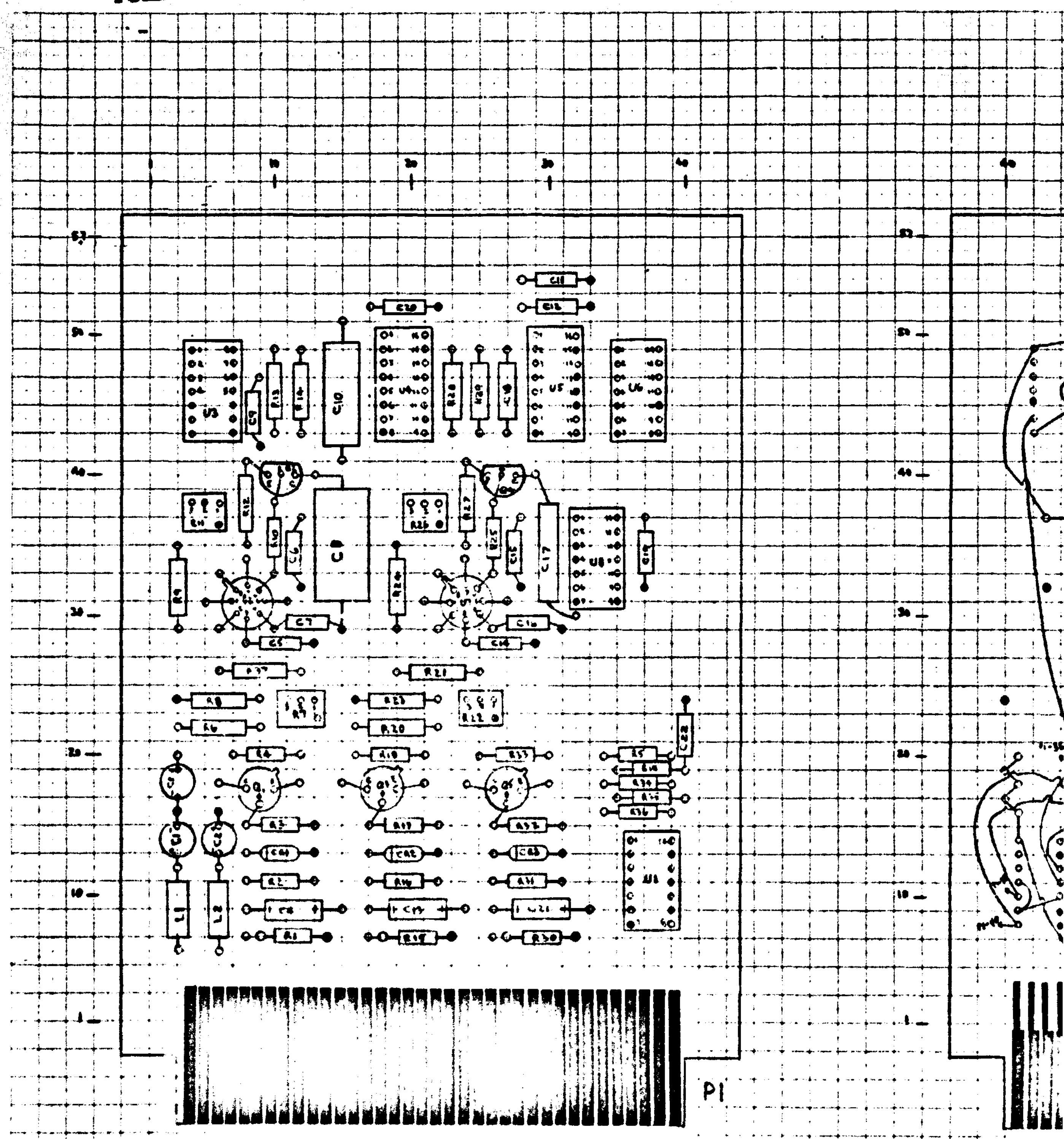
RCA RCA CORPORATION NEW YORK, NY
ASTRO-ELECTRONICS DIVISION PRINCETON, NEW JERSEY

SCHEMATIC
SINGLE VERT. AND HORIZ. LINE CURSOR - BD-A3

SIZE	CODE IDENT NO	
D	49671	SK 2288697

SCALE | SHEET 1 OF 1

FOLDOUT FRAME 1



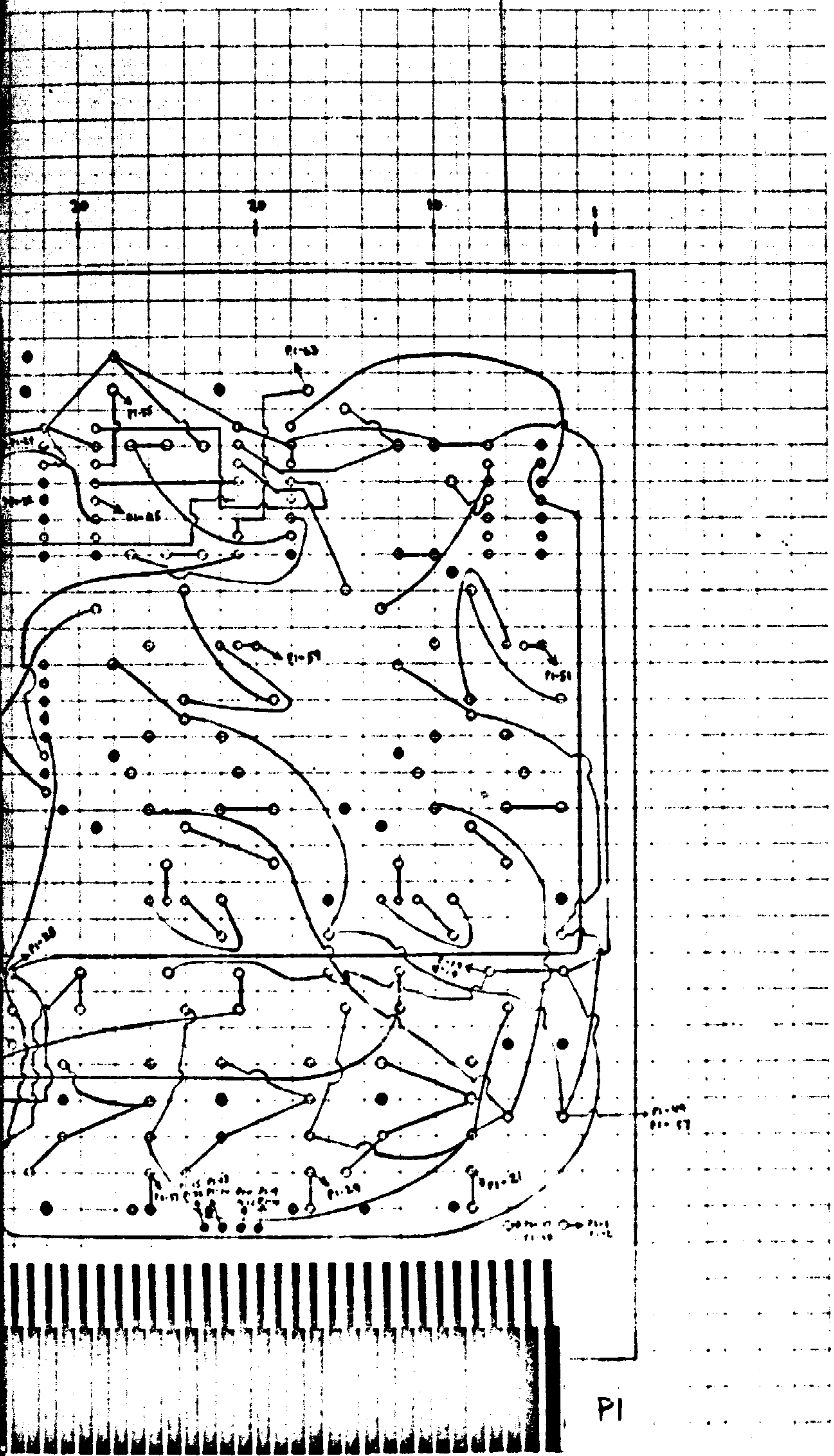
FRONT VIEW
(COMPONENT SIDE)

NOTES

1. • DENOTES SOLDER CONNECTION TO GROUND PLANE
2. ALL I.C.S. SHOWN TOP VIEW
3. ALL TRANSISTORS SHOWN BOTTOM VIEW

REVISIONS				
SYM	ZONE	DESCRIPTION	DATE	APPROVED

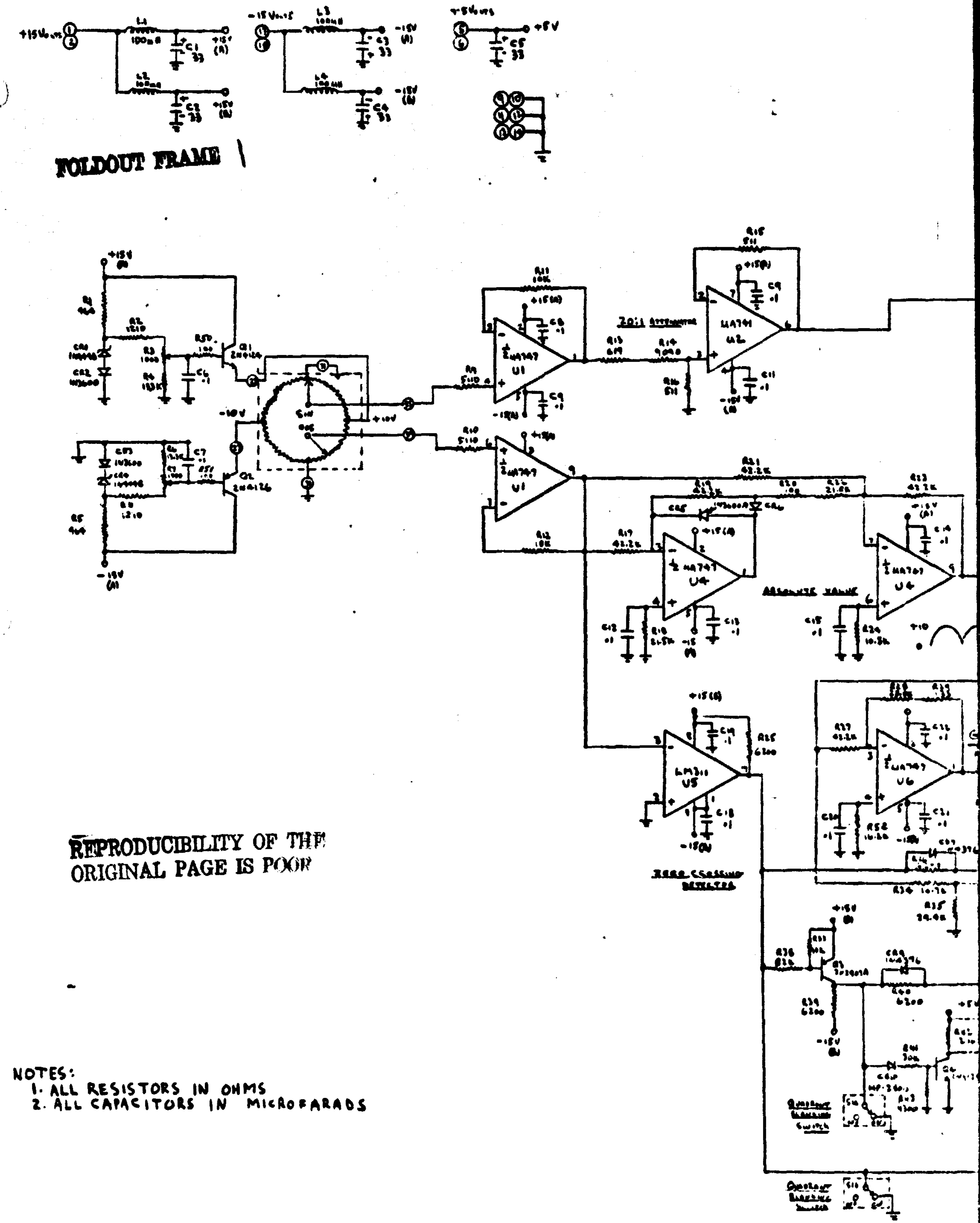
FOLDOUT FRAME 2



REAR VIEW
(GROUND PLANE)

CONTRACT NO. NAS9-14617	RADIO CORPORATION OF AMERICA CAMDEN, N. J. ASTRO ELECTRONICS DIV. PLANT
COMMODITY CODE	ASSEMBLY SINGLE VERTICAL & HORIZONTAL LINE CUSOR BOARD A3
DRAWN DATE	
CHECKED DATE	
DESIGN ACTIVITY APPD DATE	CODE IDENT NO. 49671 · SIZE D · SK 2288698
	SCALE · WEIGHT · SHEET

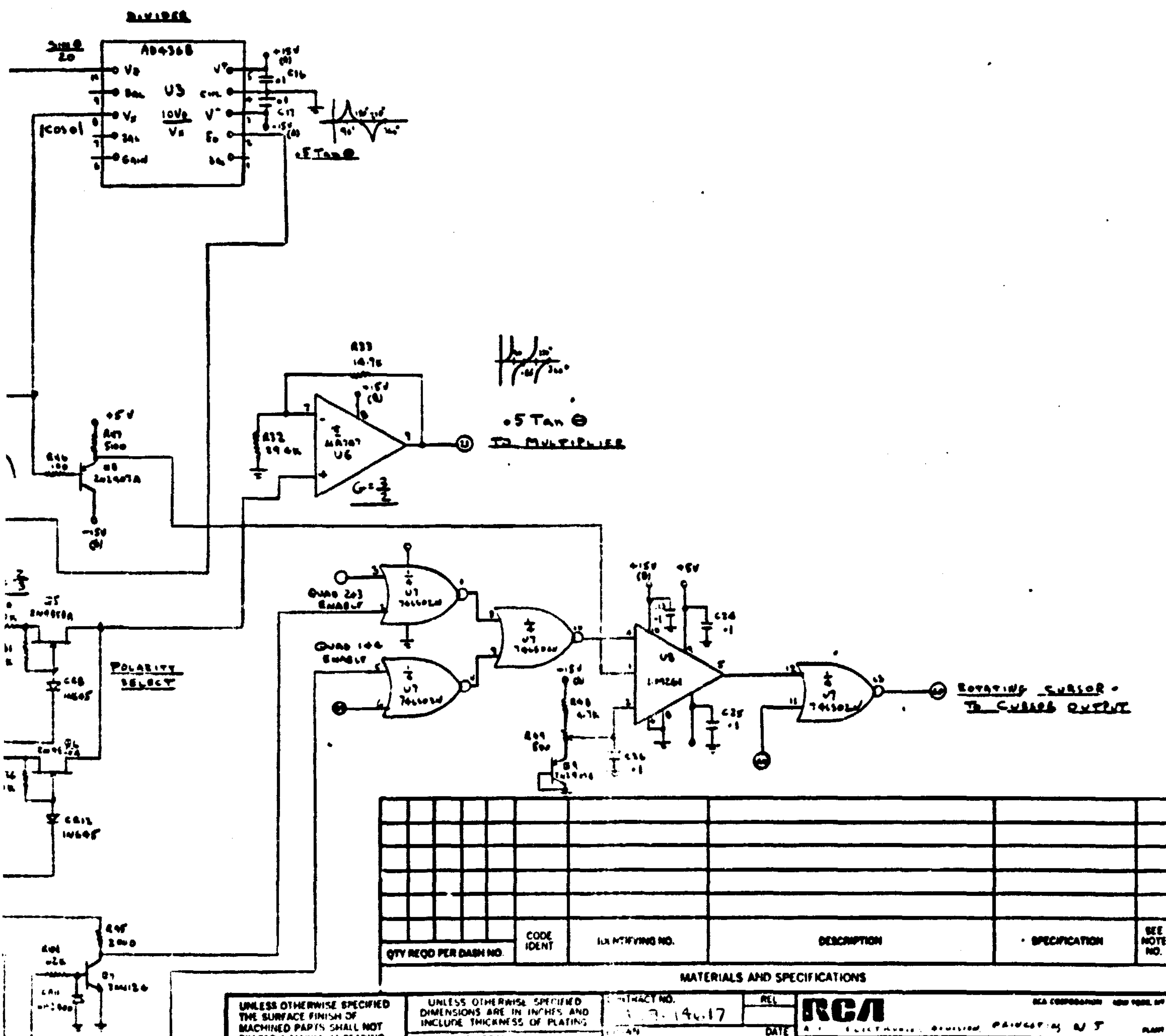
FIRST MADE FOR	
NEXT ASS'Y	USED ON



NOTES:
1. ALL RESISTORS IN OHMS
2. ALL CAPACITORS IN MICROFARADS

ZONE	LTR	REVISIONS DESCRIPTION	DATE	APPROVED

FOLDOUT FRAME 2



QTY REQD PER DASH NO.	CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING IN √ PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5 66

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL STD 9

NEXT ASSY	USED ON
FIRST APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS

RCA COMMODITY CODE

CONTRACT NO. ...-14617

DRAWN G. HUBIT

CHECKED

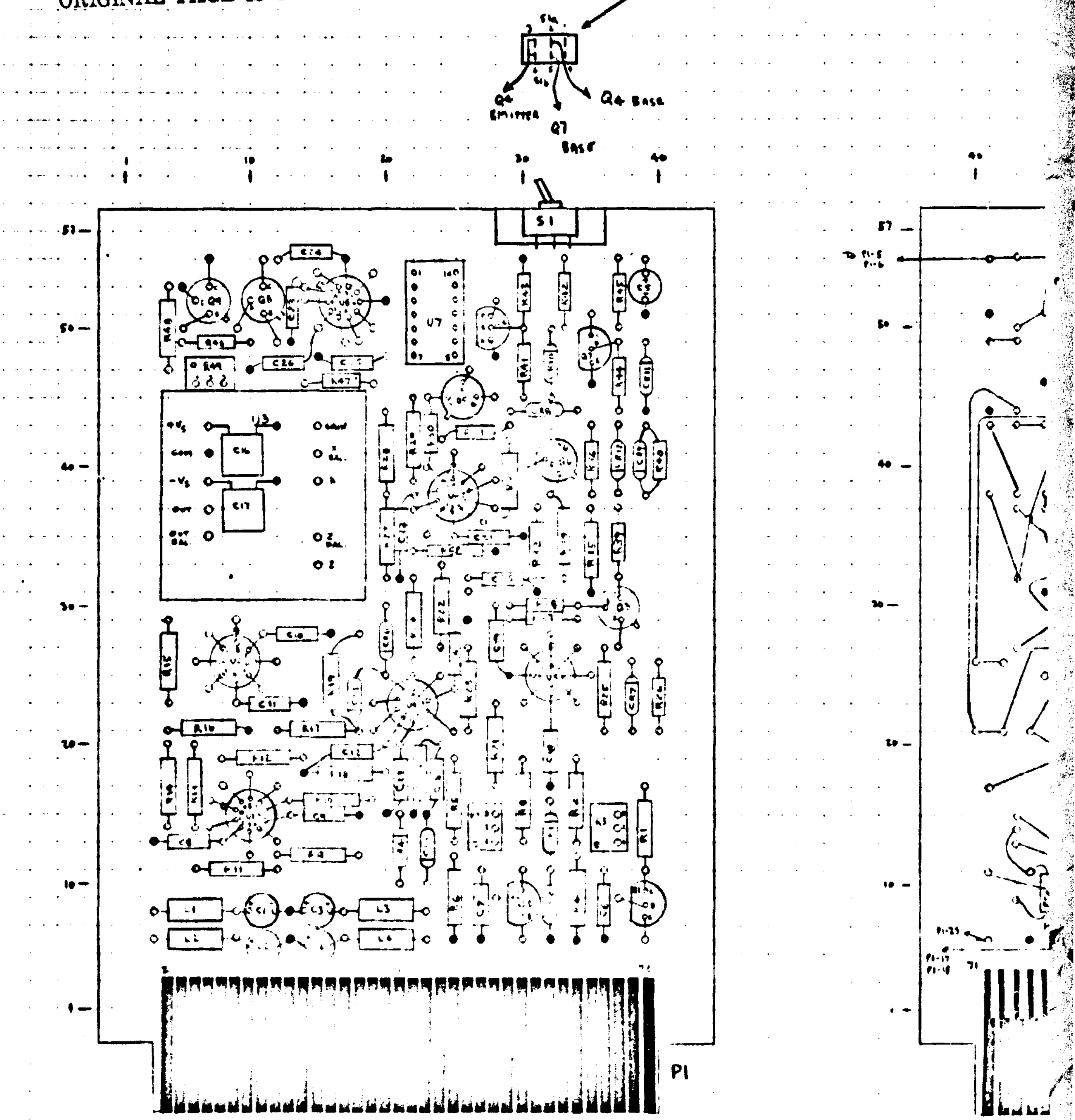
DESIGN ACTIVITY APPD 2/12/76

RCA RCA CORPORATION NEW YORK, NY

SCHEMATIC
ROTATING CURSOR BD. A4

SIZE	CODE IDENT NO	
D	49671	SK 2288699

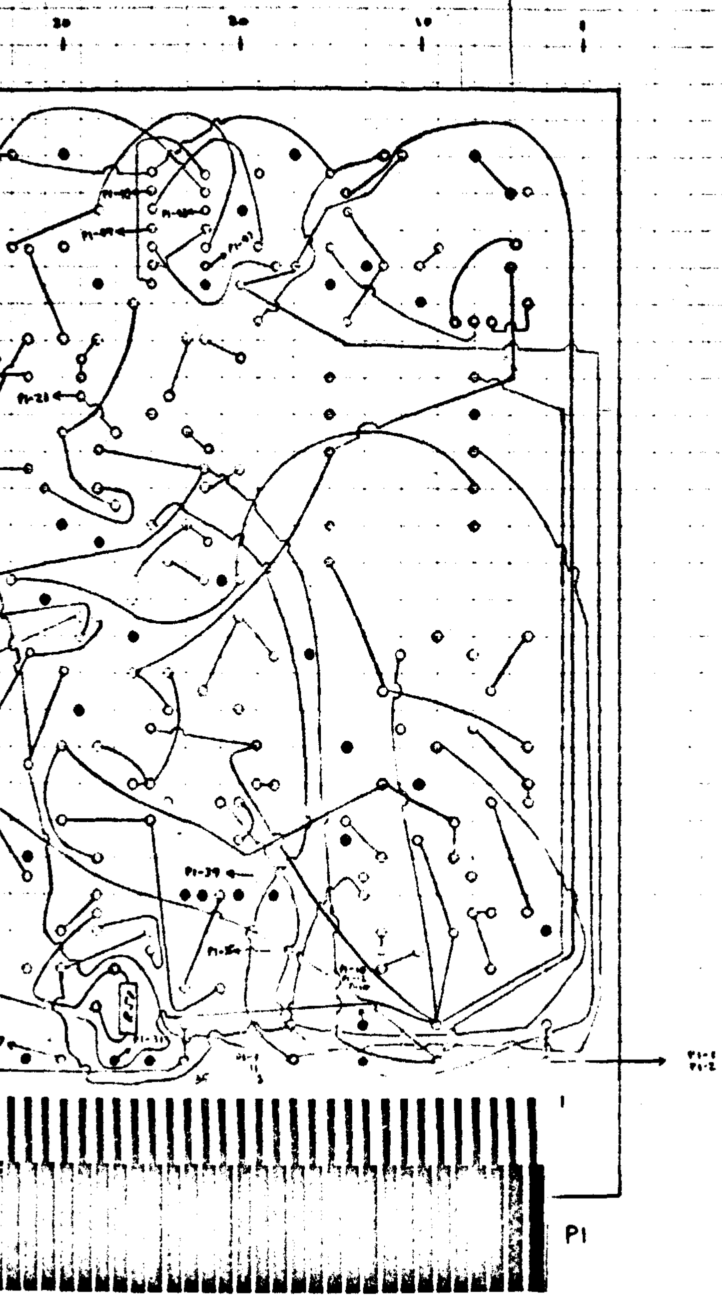
SCALE | SHEET



FRONT VIEW

NOTES

1. • DENOTES SOLDER CONNECTION TO GROUND PLANE
2. ALL I.C.'S SHOWN TOP VIEW
3. ALL TRANSISTORS SHOWN BOTTOM VIEW
4. C16 & C17 MOUNTED ON WIRING SIDE OF BOARD

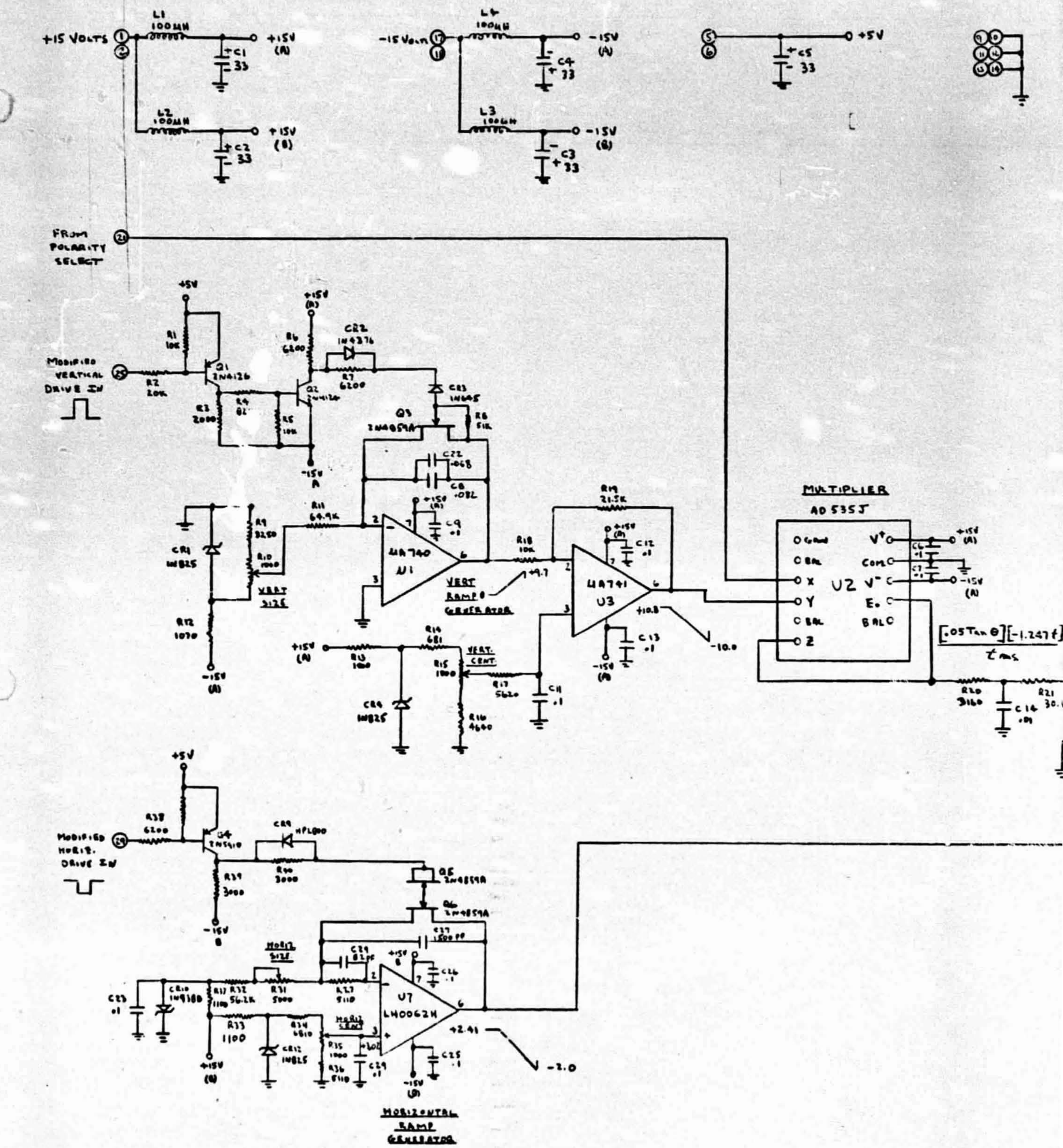


REAR VIEW
(GROUND PLANE)

FOLDOUT FRAME 2.

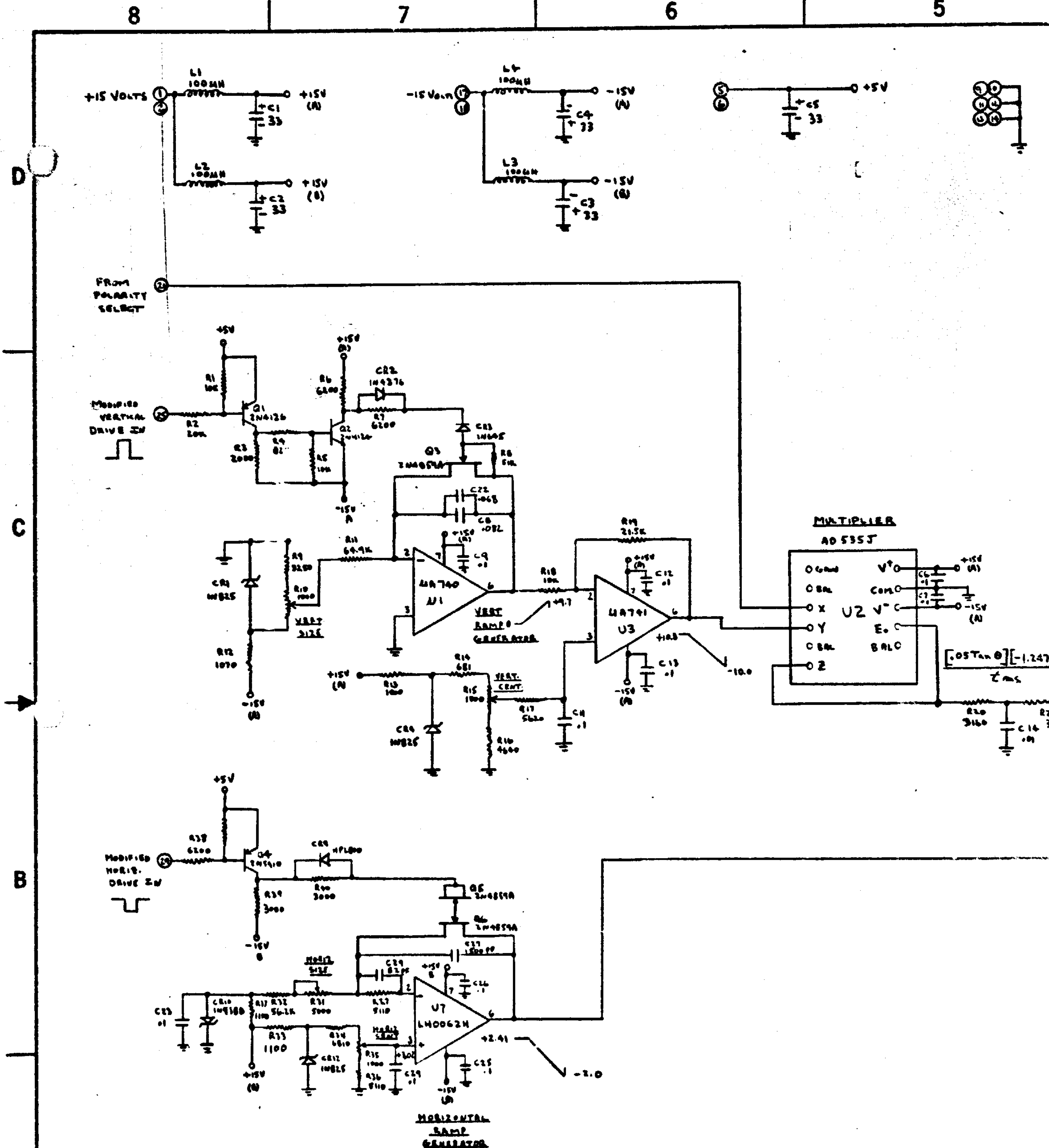
REVISIONS				
SYM	ZONE	DESCRIPTION	DATE	APPROVED

CONTRACT NO. NAS5-14617	RADIO CORPORATION OF AMERICA CAMDEN, N. J. ASTRO ELECTRONICS DIVISION-PRINCETON N.J. PLANT
COMMODITY CODE	
DRAWN S.G. HUBIT DATE	ASSEMBLY ROTATING VECTOR CURSOR BOARD A4
CHECKED DATE	
DESIGN ACTIVITY APPD DATE 2-11-76	CODE IDENT NO 49671 SIZE D SK 2288851
FIRST MADE FOR	SCALE WEIGHT SHEET
NEXT ASS'Y USED ON	



NOTES:
1. ALL RESISTORS IN OHMS
2. ALL CAPACITORS IN MICROFARADS
3. SYMBOLS NOT USED R27, Q4,

FOLDOUT FRAME



NOTES:
1. ALL RESISTORS IN OHMS
2. ALL CAPACITORS IN MICROFARADS
3. SYMBOLS NOT USED R27, Q4,

FOLDOUT FRAME |

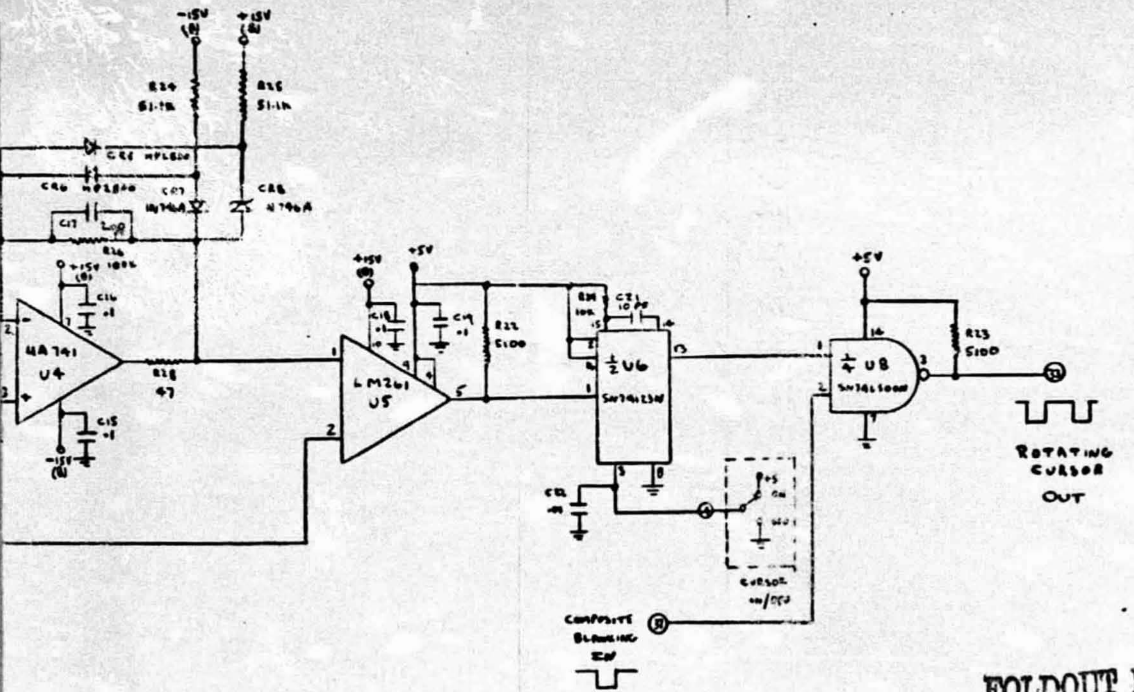
RCA 2621-3 (4-71)

4	3	2	1

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR



FOLDOUT FRAME 2

QTY REQD PER DASH NO.	CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/PER ANSI STD B46.1 — 1965

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

NEXT ASSY	USED ON
FIRST APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS ± 1/2°

RCA COMMODITY CODE:

CONTRACT NO. NAS9-14617 REL

DRAWN E.G. HUBIT DATE

CHECKED DATE

DESIGN ACTIVITY APPD. DATE M. Kravitz 2/12/76

RCA — RCA CORPORATION · NEW YORK, NY — PLANT

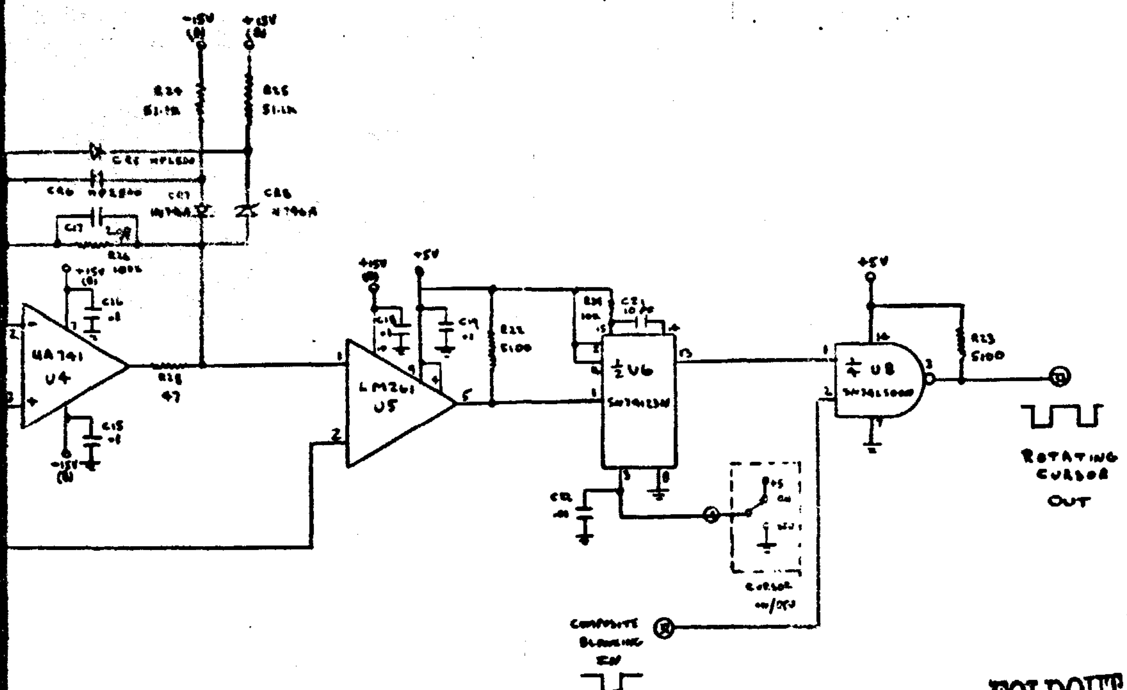
SCHEMATIC
ROTATING VECTOR CURSOR
BD.-A5-

SIZE	CODE IDENT NO.	
D	49671	SK2288852

SCALE SHEET 1 OF 1

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR



FOLDOUT FRAME 2

QTY REQD PER DASH NO.					CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	NO.

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/ PER ANSI STD B46.1 — 1/6

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

THIS DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

NEXT ASSY	USED ON
FIRST APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS ± ½°

RCA COMMODITY CODE:

CONTRACT NO. [illegible] 19617 — REL.

DRAWN: E G HUBIT — DATE

CHECKED — DATE

DESIGN ACTIVITY APPD. — DATE

M. Kravitz 2/12/76

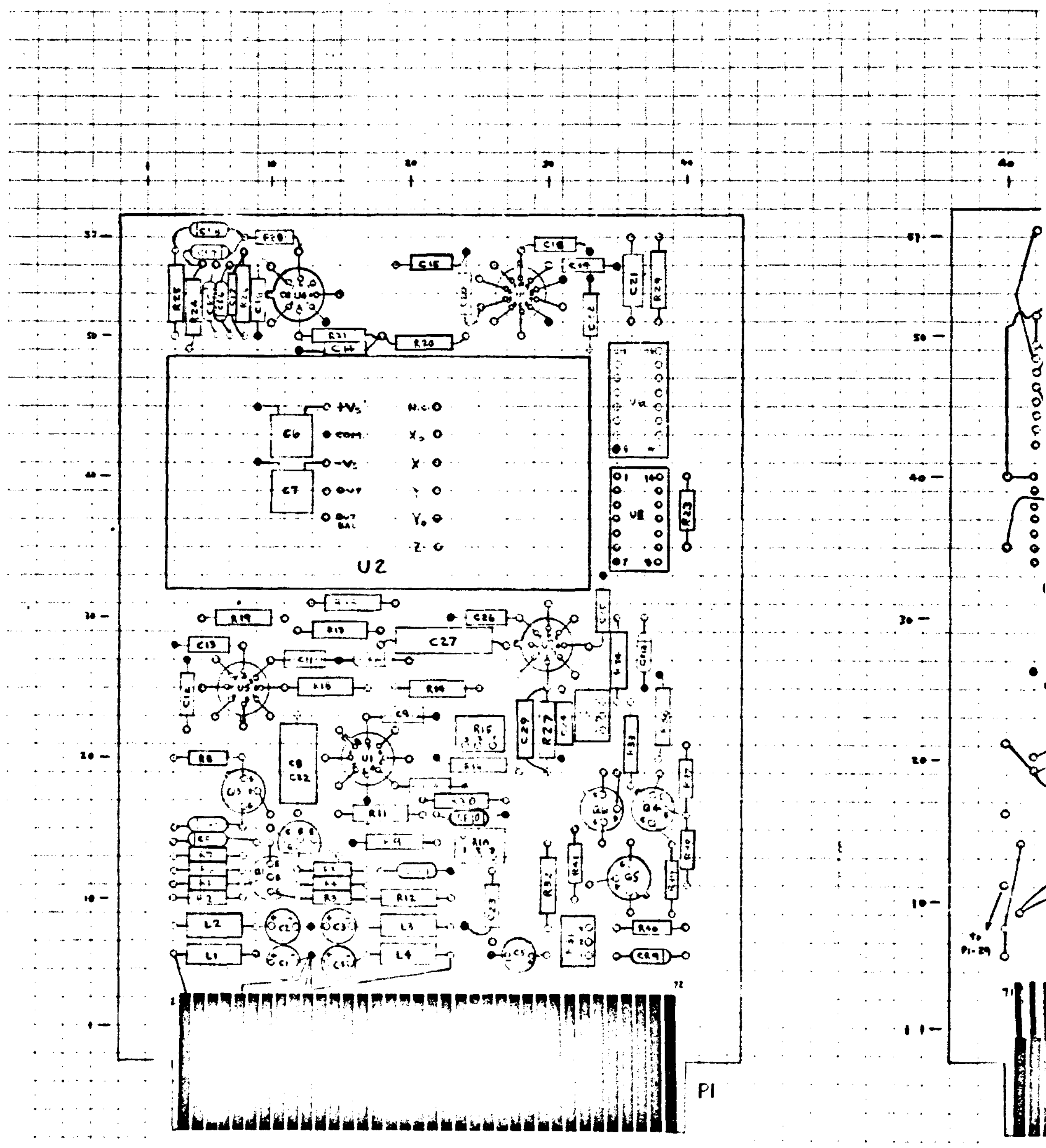
RCA — RCA CORPORATION NEW YORK, NY — PLANT

SCHEMATIC
ROTATING VECTOR CURSOR
BD.-A5-

SIZE	CODE IDENT NO.	
D	49671	SK2288852

SCALE — SHEET 1 OF 1

FOLDOUT FRAME



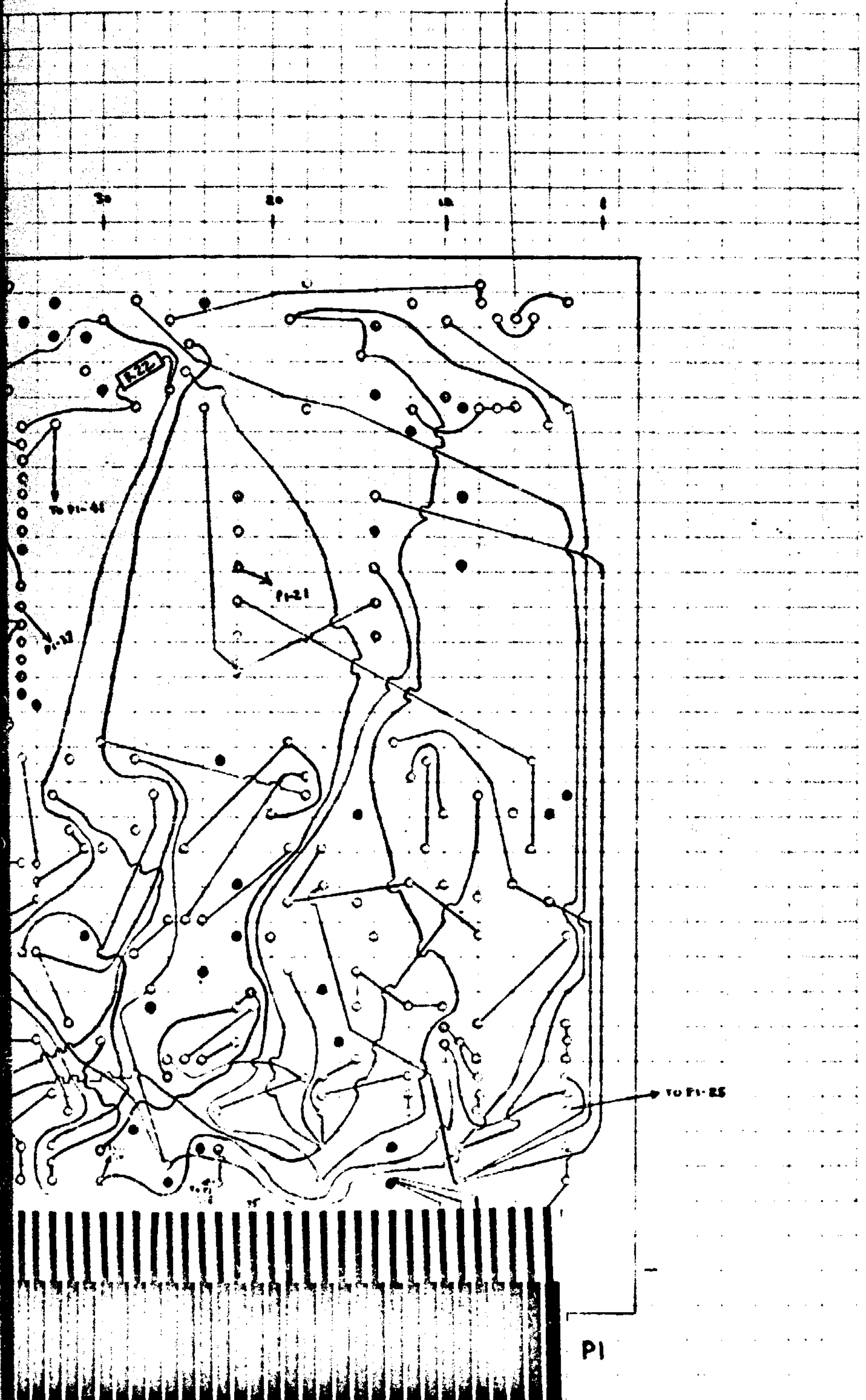
REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

NOTES

1. ● DENOTES CONNECTION TO GROUND PLANE
2. ALL I.C.'S MOUNTED WITH HEADER FACING UP, ALL TRANSISTOR HEADERS FACING BOARD

SYM	ZONE	REVISIONS DESCRIPTION	DATE	APPROVED

FOLDOUT FRAME 2



QTY 504	QTY 503	QTY 502	QTY 501	ITEM NO.	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

LIST OF MATERIALS

DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING		
TOLERANCES ON FINISHED DIMENSIONS UNLESS OTHERWISE SPECIFIED		
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .005
6 TO 24	± .03	± .010
ABOVE 24	± .06	± .015
ANGULAR DIMENSIONS ± ½°		
SEE RCA PURCH SPEC FOR STOCK TOL		

FIRST MADE FOR	
NEXT ASS'Y	USED ON
	P.O.T.S.

ALL EXTERNAL THREADS TO BE CLASS 2A BEFORE PLATING AND CLASS 2 AFTER PLATING. ALL INTERNAL THREADS TO BE CLASS 2B UNLESS OTHERWISE SPECIFIED

CONTRACT NO. NAS9-14617

COMMODITY CODE

DRAWN ... HUBIT DATE

CHECKED DATE

DESIGN ACTIVITY APPD. DATE 10-17-75

RADIO CORPORATION OF AMERICA
CAMDEN, N. J.
ASTRO ELECTRONICS DIVISION, PRINCETON, N.J. PLANT

ASSEMBLY
ROTATING VECTOR CURSOR
BOARD A5

CODE IDENT NO.	SIZE	
49671	D	SK2288853
SCALE	WEIGHT	SHEET 1 of 1

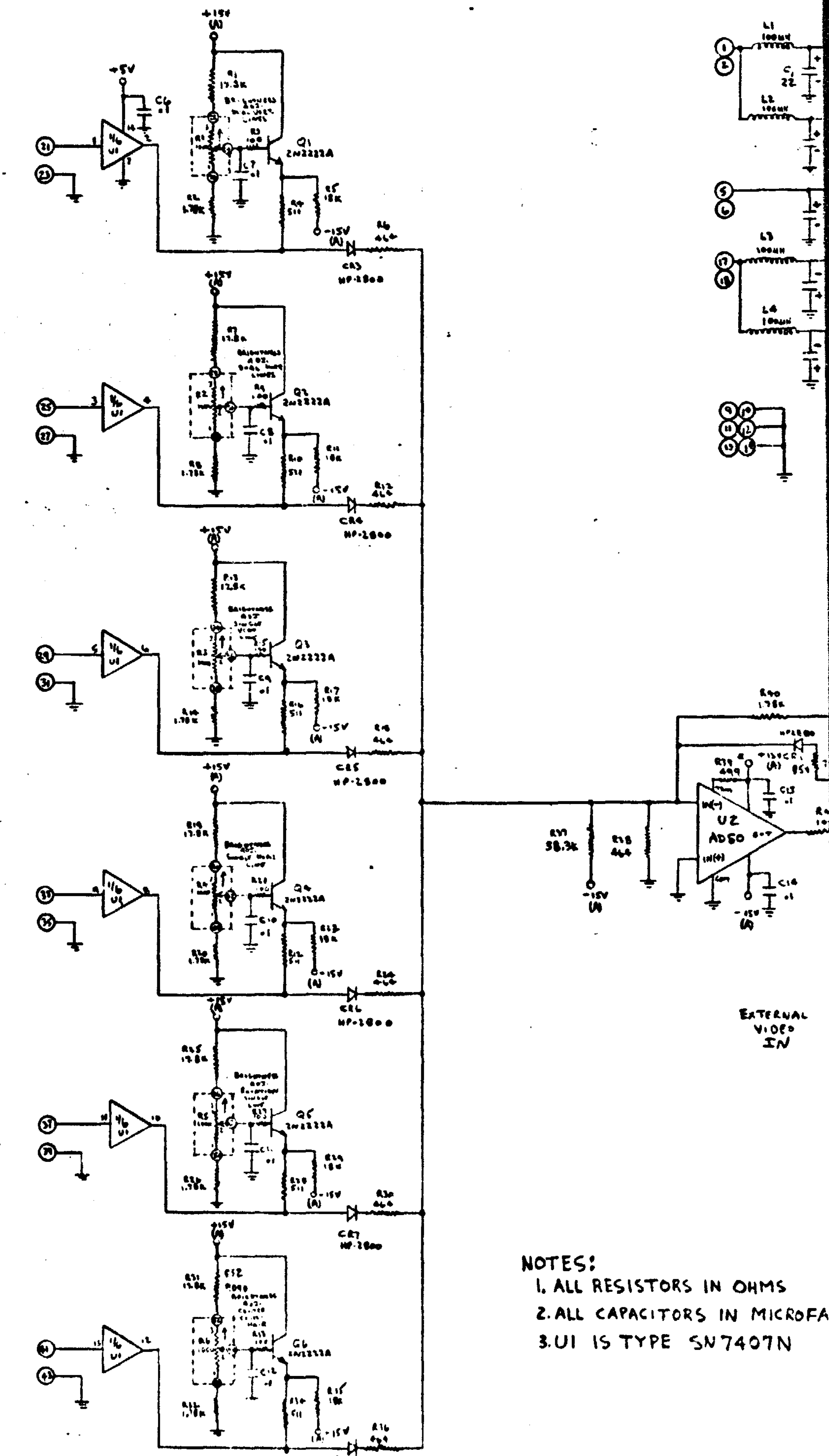
8 7 6 5

D

C

B

A



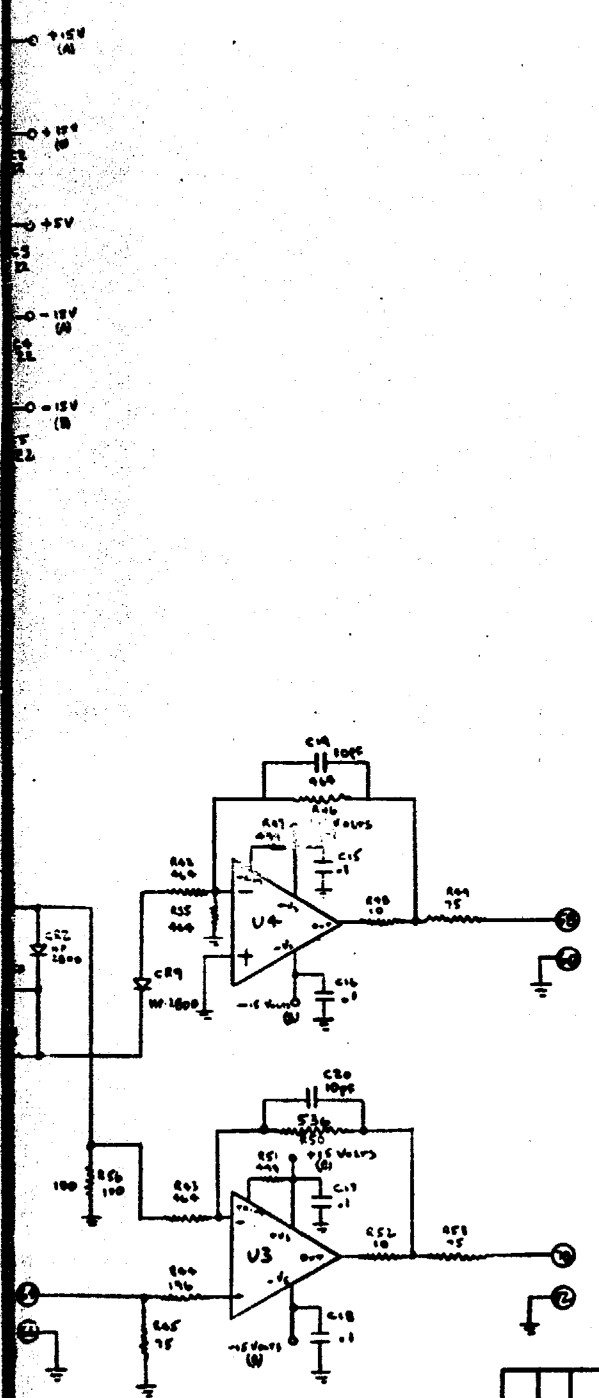
NOTES:
1. ALL RESISTORS IN OHMS
2. ALL CAPACITORS IN MICROFA
3. U1 IS TYPE SN7407N

FOLDOUT FRAME \

4	3	2	1

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED



REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

FOLDOUT FRAME 2

QTY REQD PER DASH NO.					CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5 66

THIS DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

NEXT ASSY	USED ON
FIRST APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS ± ½°

RCA COMMODITY CODE:

CONTRACT NO. ...3-14617 REL

DRAWN ...G. HUBIT DATE

CHECKED DATE

DESIGN ACTIVITY APPD. DATE 6/12/76

RCA RCA CORPORATION · NEW YORK, NY

... ELECTRONICS DIVISION, PRINCETON, N.J. PLANT

SCHEMATIC

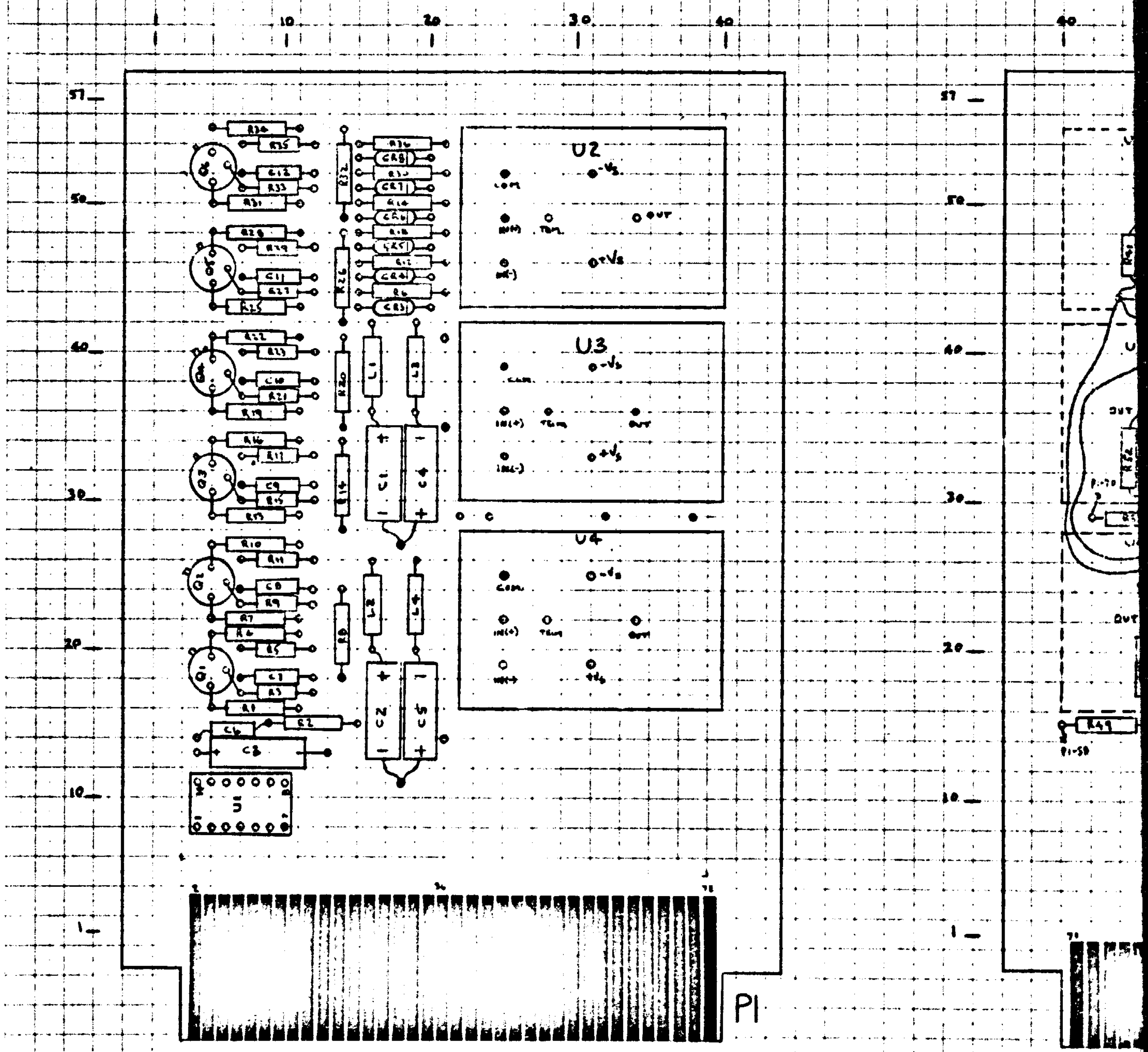
CURSOR MIXER - VIDEO/CURSOR

CURSOR - OUTPUT BD.-A6

SIZE	CODE IDENT NO.	
D	49671	SK2288854

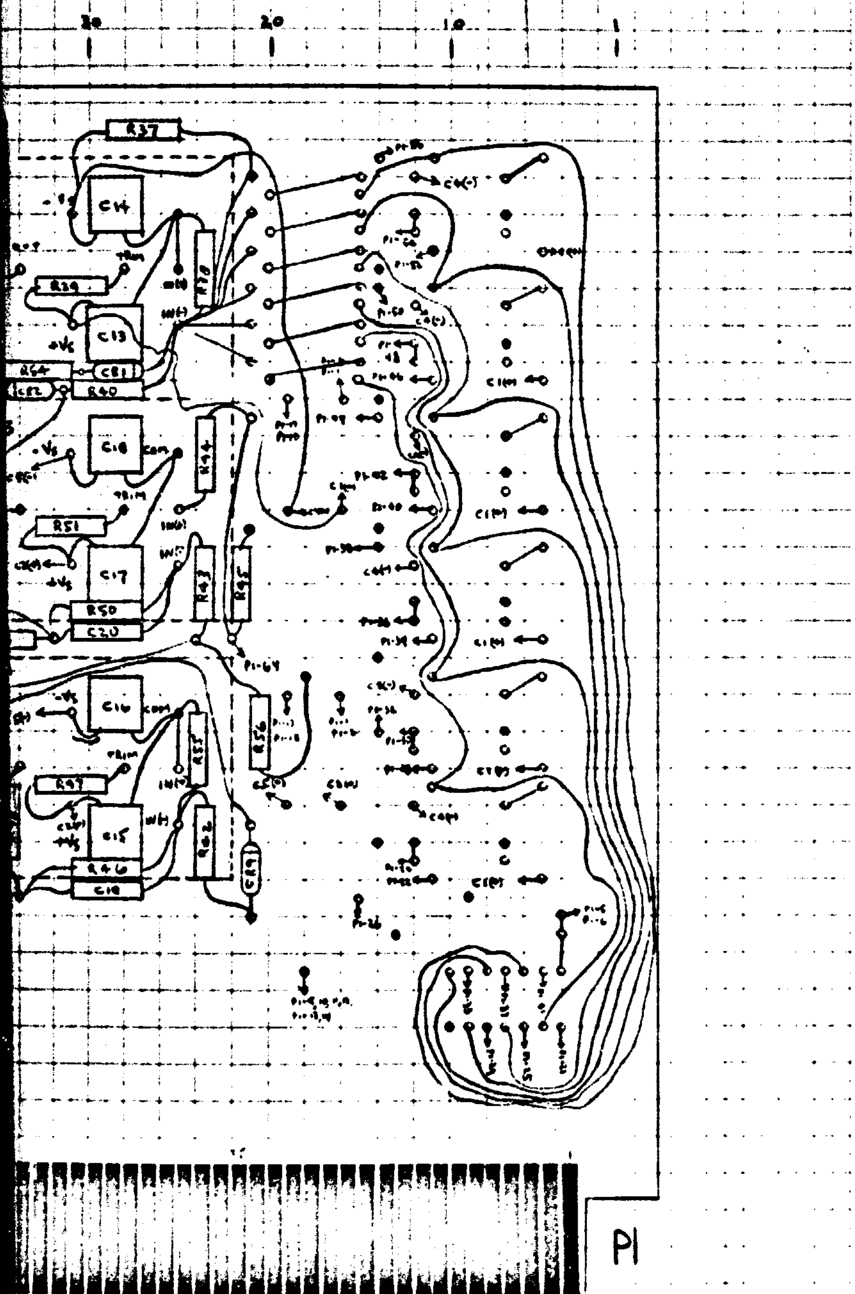
SCALE SHEET

FOLDOUT FRAME 1



SYM	ZONE	REVISIONS DESCRIPTION	DATE	APPROVED

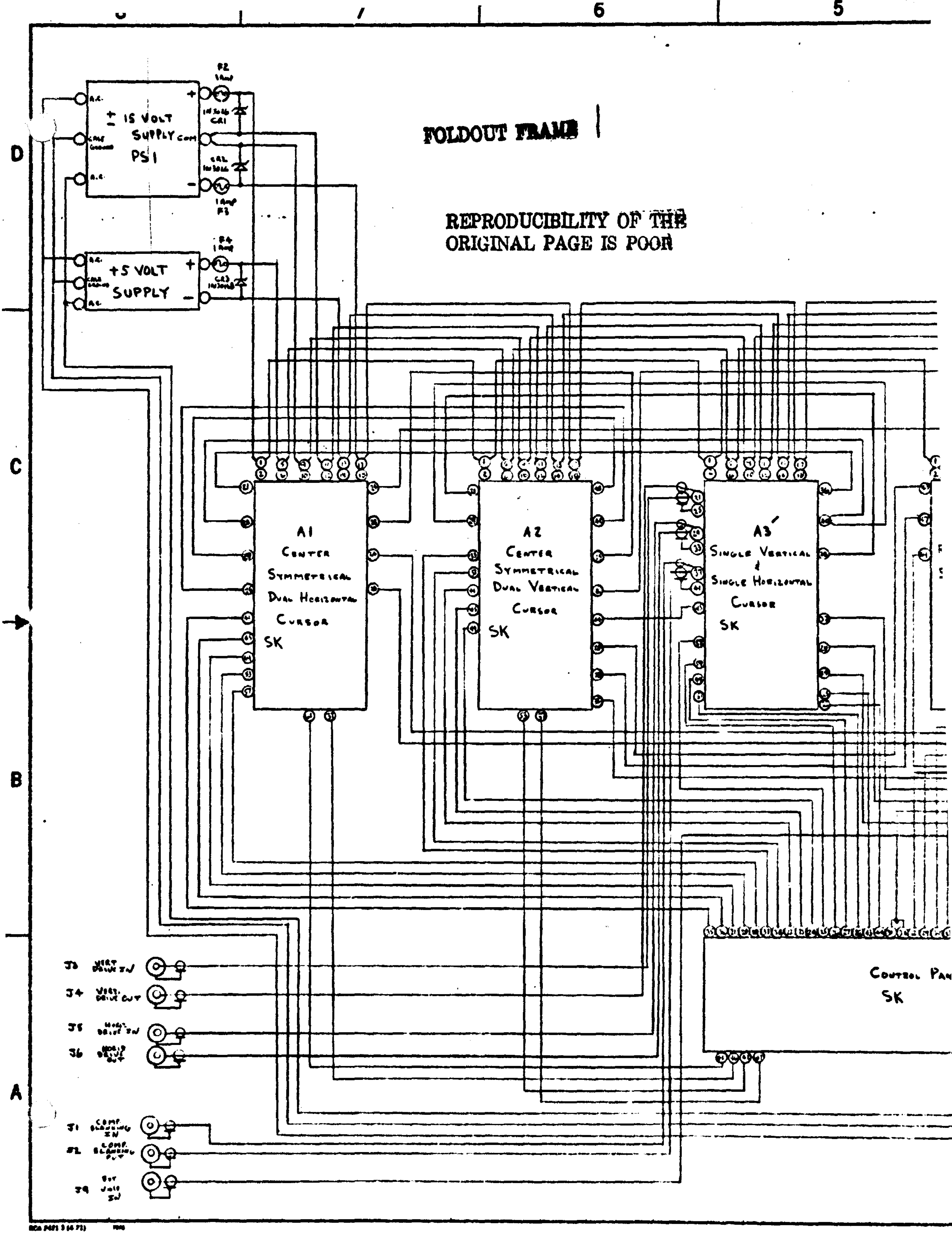
FOLDOUT FRAME 2



REAR VIEW

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

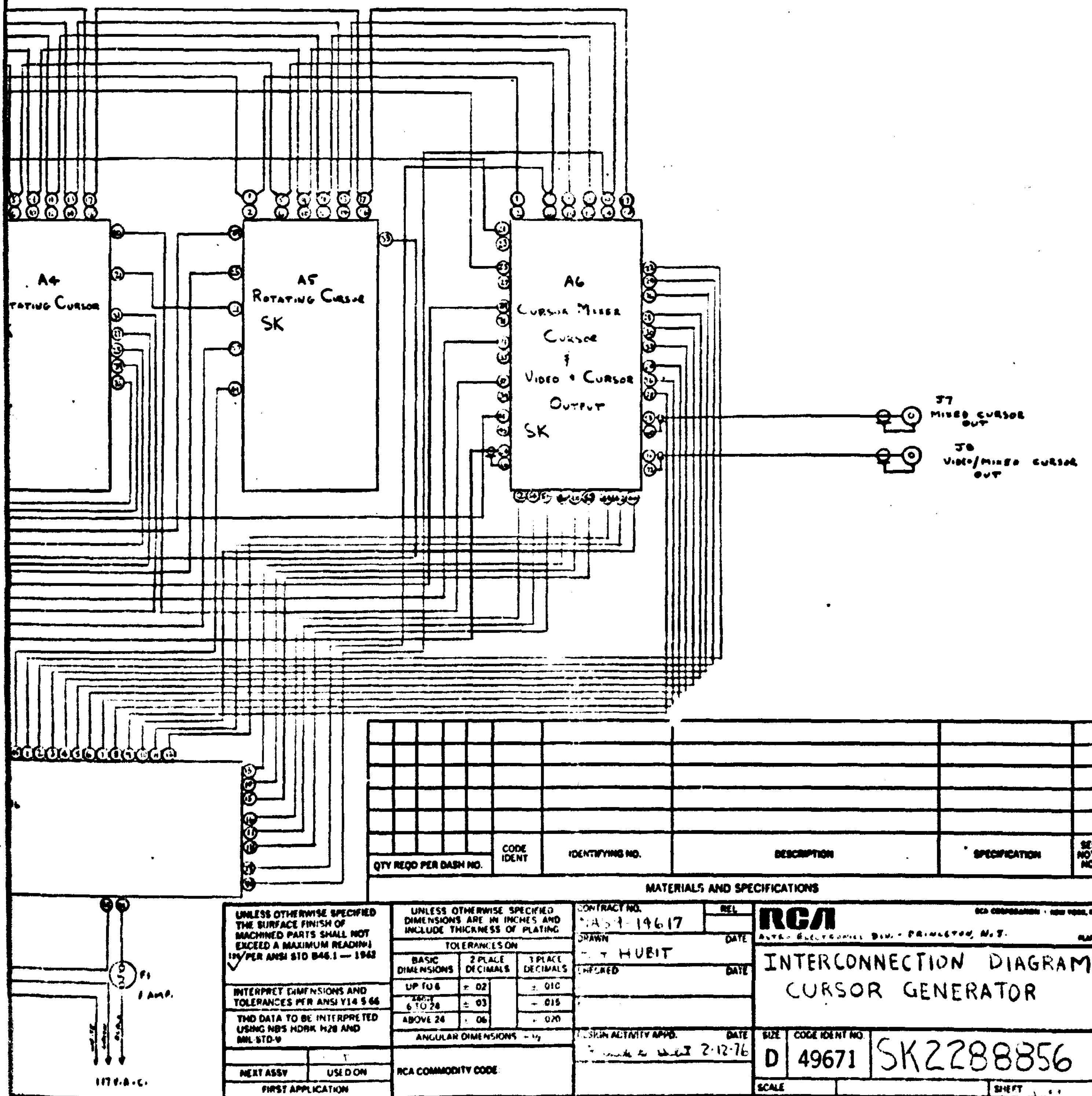
CONTRACT NO. NAS9-14617	RADIO CORPORATION OF AMERICA CAMDEN, N. J. PLANT
COMMODITY CODE	
DRAWN F.G. HAIT DATE	ASSEMBLY CURSOR MIXER- VIDEO/CURSOR- CURSOR OUTPUT BOARD A6
CHECKED DATE	
DESIGN ACTIVITY APPD DATE	CODE IDENT NO. SIZE SK220085


6
5
D
C
B
A
± 15 VOLT SUPPLY
PS1
+5 VOLT SUPPLY
A1
CENTER SYMMETRICAL DUAL HORIZONTAL CURSOR
SK
A2
CENTER SYMMETRICAL DUAL VERTICAL CURSOR
SK
A3
SINGLE VERTICAL & SINGLE HORIZONTAL CURSOR
SK
SK
J3
J4
J5
J6
J1
J2

4	3	2	1

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

FOLDOUT FRAME 2



QTY REQD PER DASH NO.	CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/ PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5 66

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

NEXT ASSY	USED ON
FIRST APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS ± ½

RCA COMMODITY CODE

CONTRACT NO. NAS 9-14617

REL

DRAWN ... HUBIT DATE

CHECKED DATE

DESIGN ACTIVITY APPD. DATE 2-12-76

RCA CORPORATION · NEW YORK, NY

ASTRO-ELECTRONICS DIV. · PRINCETON, N.J.

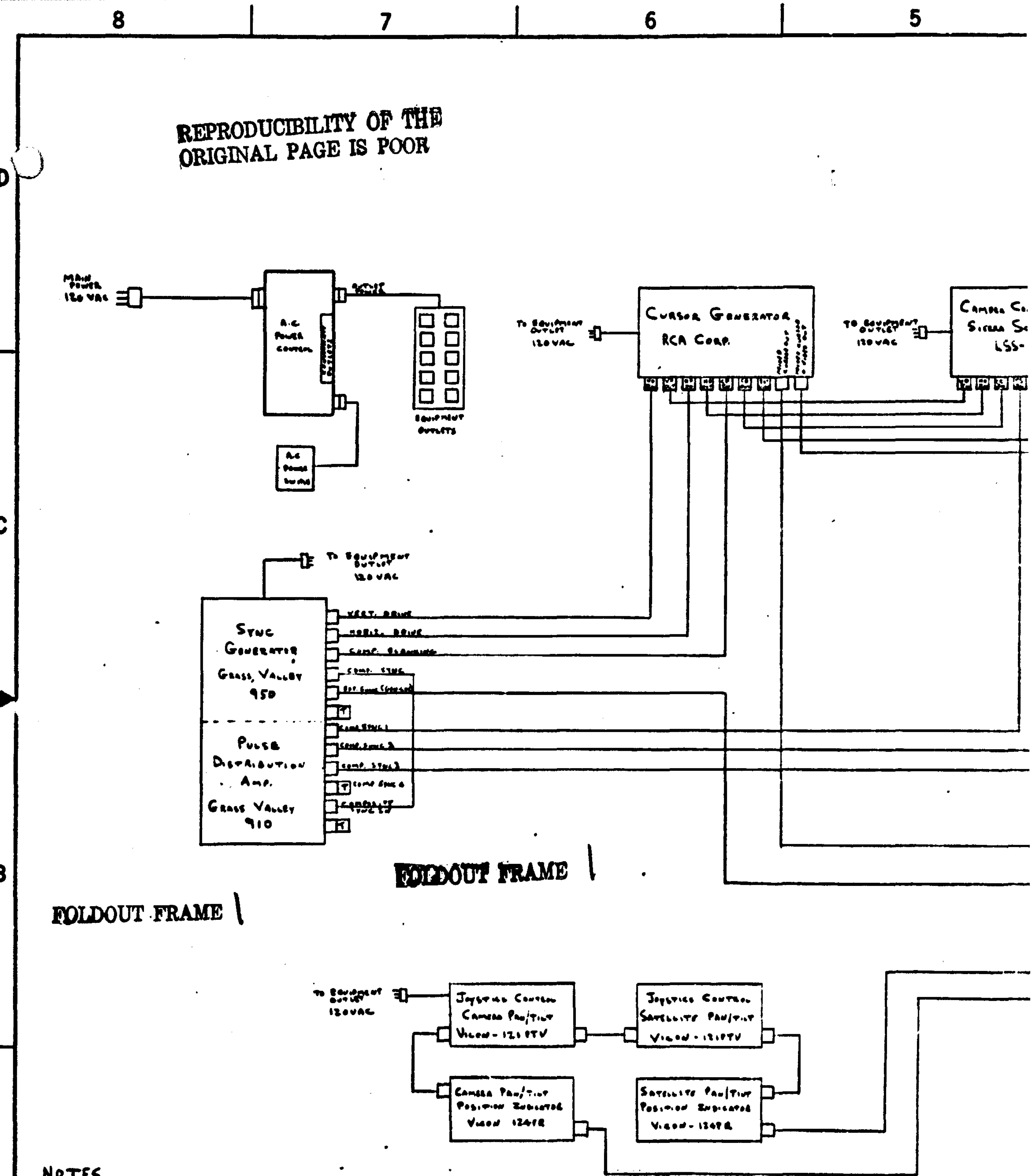
INTERCONNECTION DIAGRAM CURSOR GENERATOR

SIZE	CODE IDENT NO.	
D	49671	SK2288856

SCALE

SHEET

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR



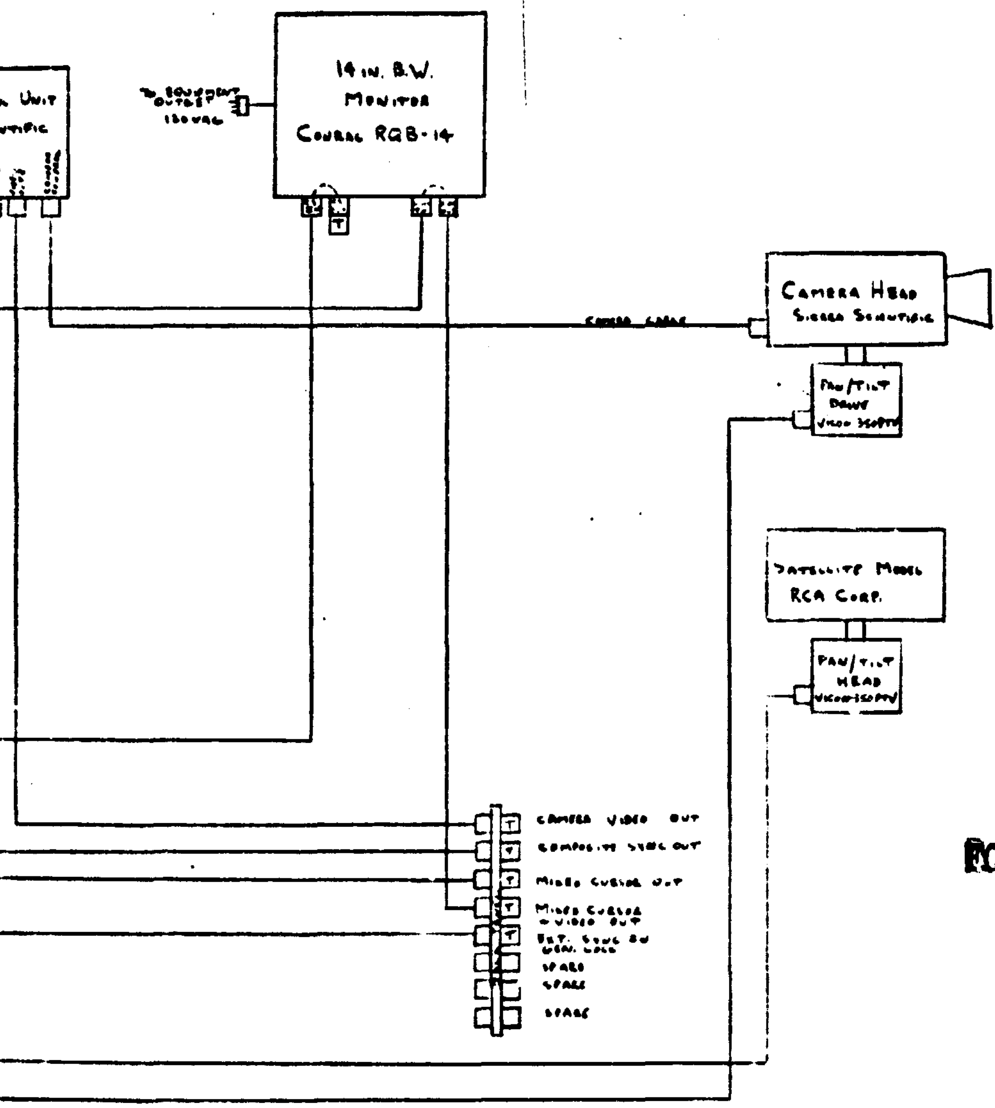
FOLDOUT FRAME

FOLDOUT FRAME

NOTES
1. SYMBOL 'T' IS 75 OHM TERMINATION

ZONE	LTR	REVISIONS DESCRIPTION	DATE	APPROVED

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR



FOLDOUT FRAME 2

QTY REQD PER DASH NO.	CODE IDENT	IDENTIFYING NO	DESCRIPTION	SPECIFICATION	SEE NOTE NO

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5 46

THIS DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

NEXT ASSY	USED ON

FIRST APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS

RCA COMMODITY CODE

DATE 2-12-76

RCA

PAYLOAD OPERATION T.V. SYSTEM INTERCONNECTION DIAGRAM

SIZE	CODE IDENT NO	
D	49671	SK2288857

SCALE SHEET

FOLDOUT FRAME 1

4 3

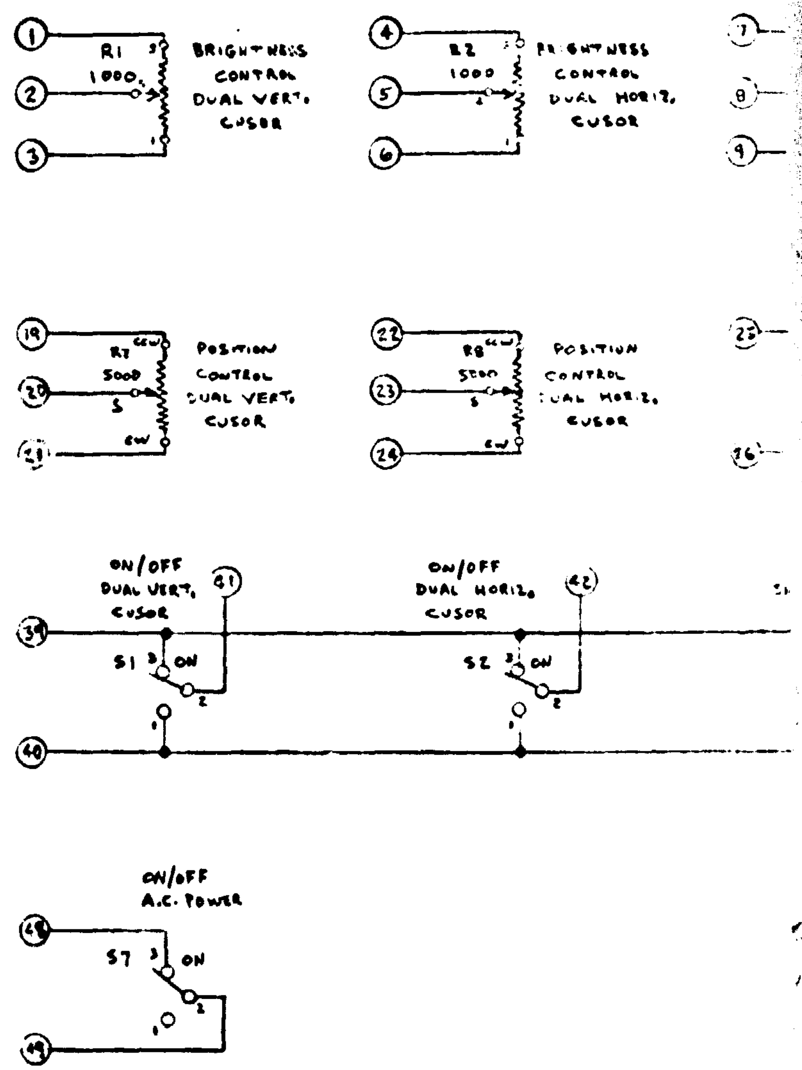
D

C

B

A

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR.

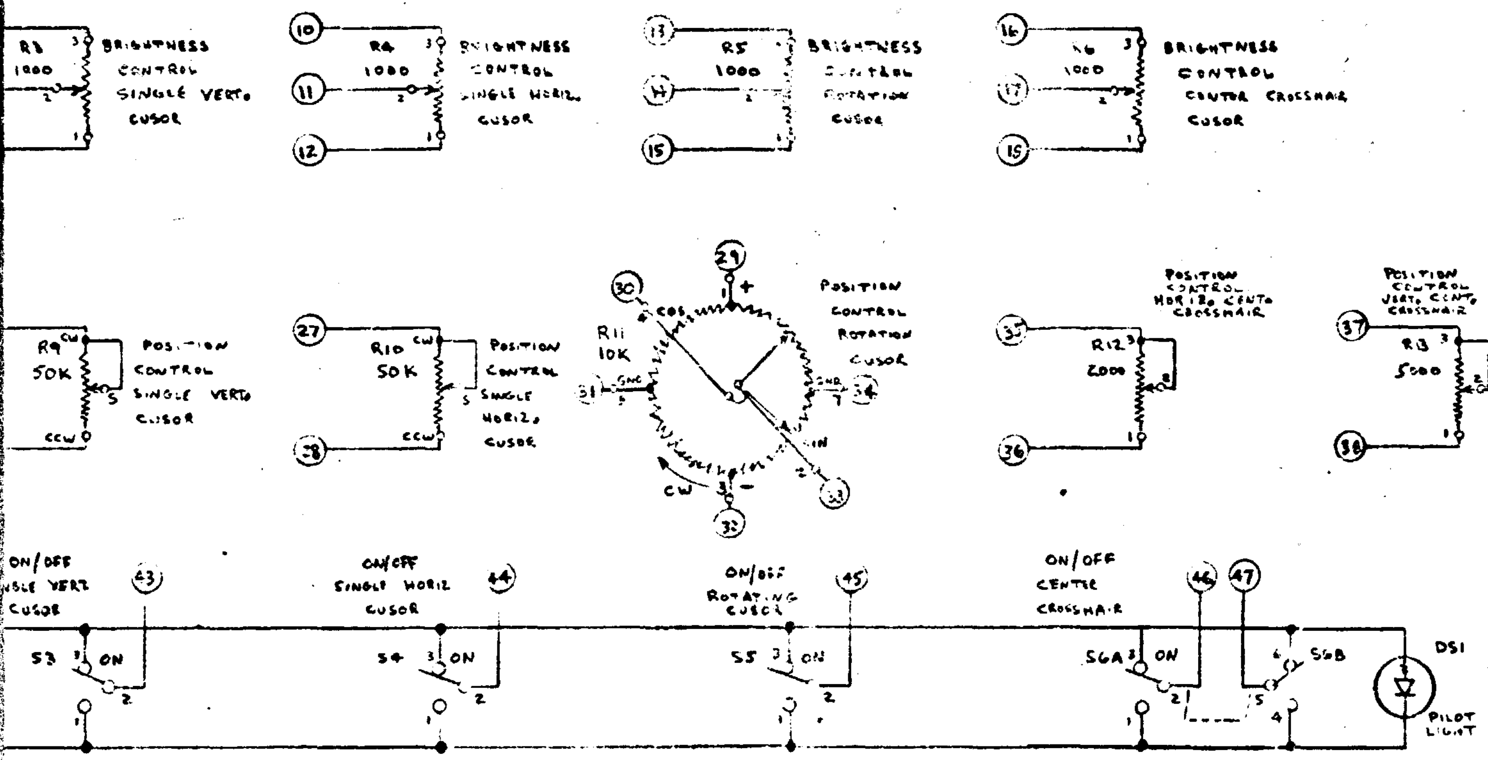


NOTES:
1. ALL RESISTORS IN OHMS
2. R11 IS SIN/COS POTENTIOMETER
COMPUTER INSTRUMENTS TYPE 206-16011-38

UNLE... THE ... MACH... EXCE...
INTER... TOLER...
THD ... USING ... MIL S...
NEXT

ZONE	LTR	REVISIONS DESCRIPTION	DATE	APPROVED

FOLDOUT FRAME 2



QTY REQD PER DASH NO.					CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.

MATERIALS AND SPECIFICATIONS

...SS OTHERWISE SPECIFIED ...URFACE FINISH OF ...NED PARTS SHALL NOT ...D A MAXIMUM READING ... ANSI STD B46.1 — 1962

...PRET DIMENSIONS AND ...ANCES PER ANSI Y14.5 66

...ATA TO BE INTERPRETED ... NBS HDBK H28 AND ...D 9

ASSY	USED ON
FIRST APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:		
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020
ANGULAR DIMENSIONS ± ½°		

RCA COMMODITY CODE

CONTRACT NO. NAS9-14617 REL

DRAWN J. HUBIT DATE

CHECKED DATE

DESIGN ACTIVITY APPD. DATE 2-12-76

RCA RCA CORPORATION NEW YORK, NY

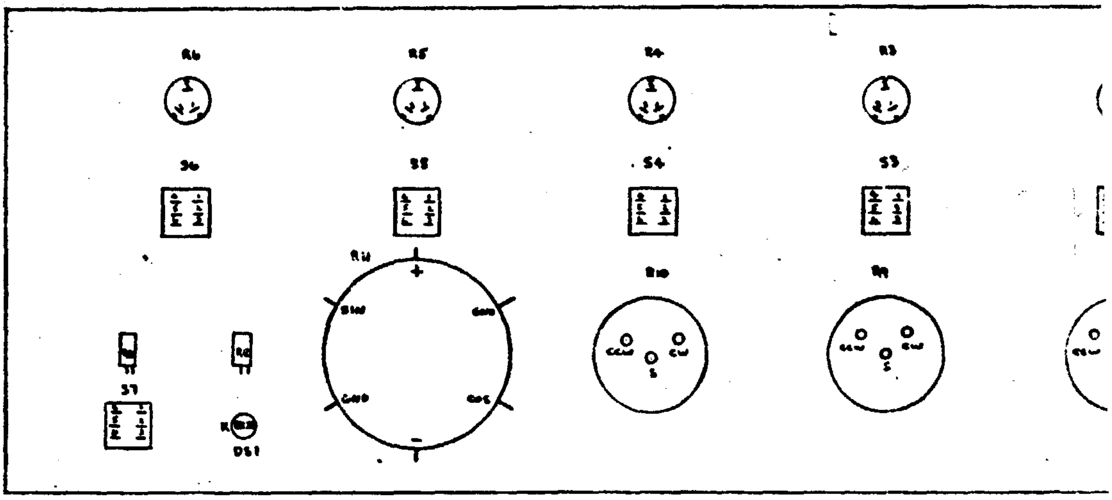
... ELECTRONICS DIVISION • PRINCETON N.J. PLANT

SCHEMATIC CUSOR GENERATOR ... PANEL

SIZE	CODE IDENT NO.	
C	49671	SK2288858

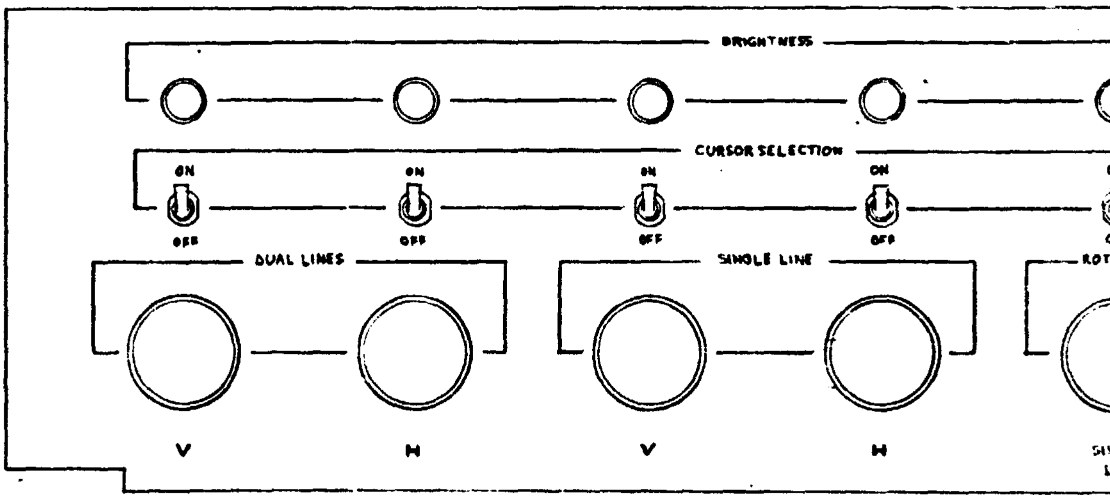
SCALE | WEIGHT | SHEET 1 OF

FOLDOUT FRAME



CONTROL PANEL - REAR VIEW

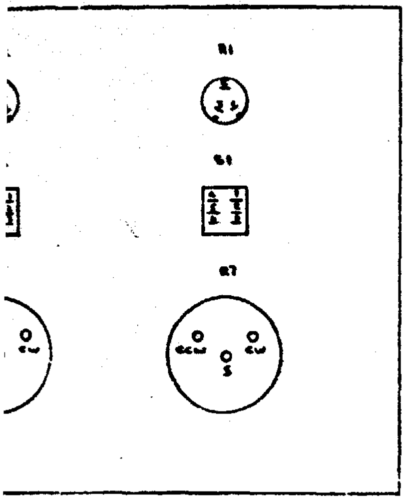
REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

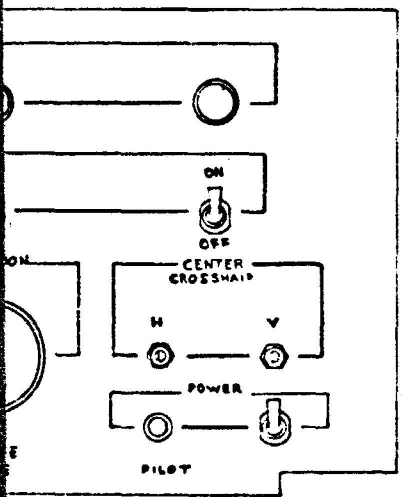


NOTES:
1. R1, R2, R3, R4, R5, R6 ARE BOURNS TYPE 3862C-12-2-102A
2. R7, R8 ARE BECKMAN TYPE 3371-5K
3. R9 & R10 ARE ALLEN BRADLEY TYPE CU5031
4. R11 IS COMPUTER INSTRUMENTS TYPE 206-16011-38
5. R12 IS BOURNS TYPE 3059J-1-202M
6. R13 IS BOURNS TYPE 3059J-1-502M
7. S1, S2, S3, S4, S5, S6, S7 ARE J.B.T TYPE 223
8. DS1 IS H.P. TYPE 5082-4860

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

FOLDOUT FRAME 2





QTY REQD PER DASH NO.					CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125 PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5 66

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD 9

NEXT ASSY	USED ON
FIRST APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON		
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020
ANGULAR DIMENSIONS ± ½		

RCA COMMODITY CODE

CONTRACT NO. [illegible] REL

DRAWN [illegible] DATE

CHECKED DATE

DESIGN ACTIVITY APPD. [illegible] DATE 2-12-76

RCA — RCA CORPORATION · NEW YORK, NY

ASTRO ELECTRONICS DIVISION PRINCETON, N.J. PLANT

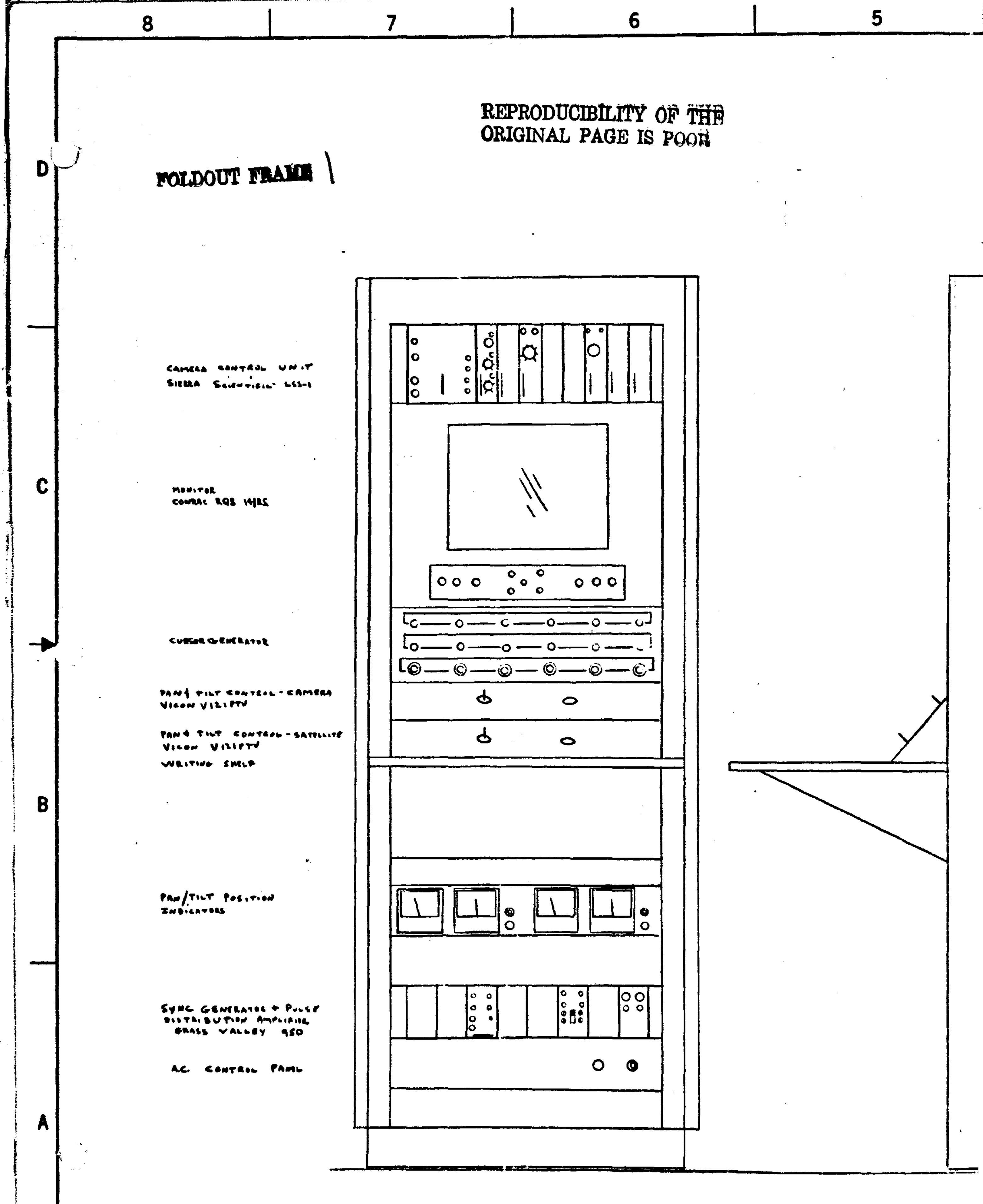
ASSEMBLY
CONTROL PANEL
CURSOR GENERATOR

SIZE	CODE IDENT NO.	
D	49671	SK2288859

SCALE SHEET 1

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

FOLDOUT FRAME



4 3 2 1

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

FOLDOUT FRAME 2

QTY REQD PER DASH NO.	CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/ PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:		
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020
ANGULAR DIMENSIONS ± ½		

CONTRACT NO. NAS7-14617 REL

DRAWN F. G. HUBIT DATE

CHECKED DATE

DESIGN ACTIVITY APPD. DATE 2-12-76

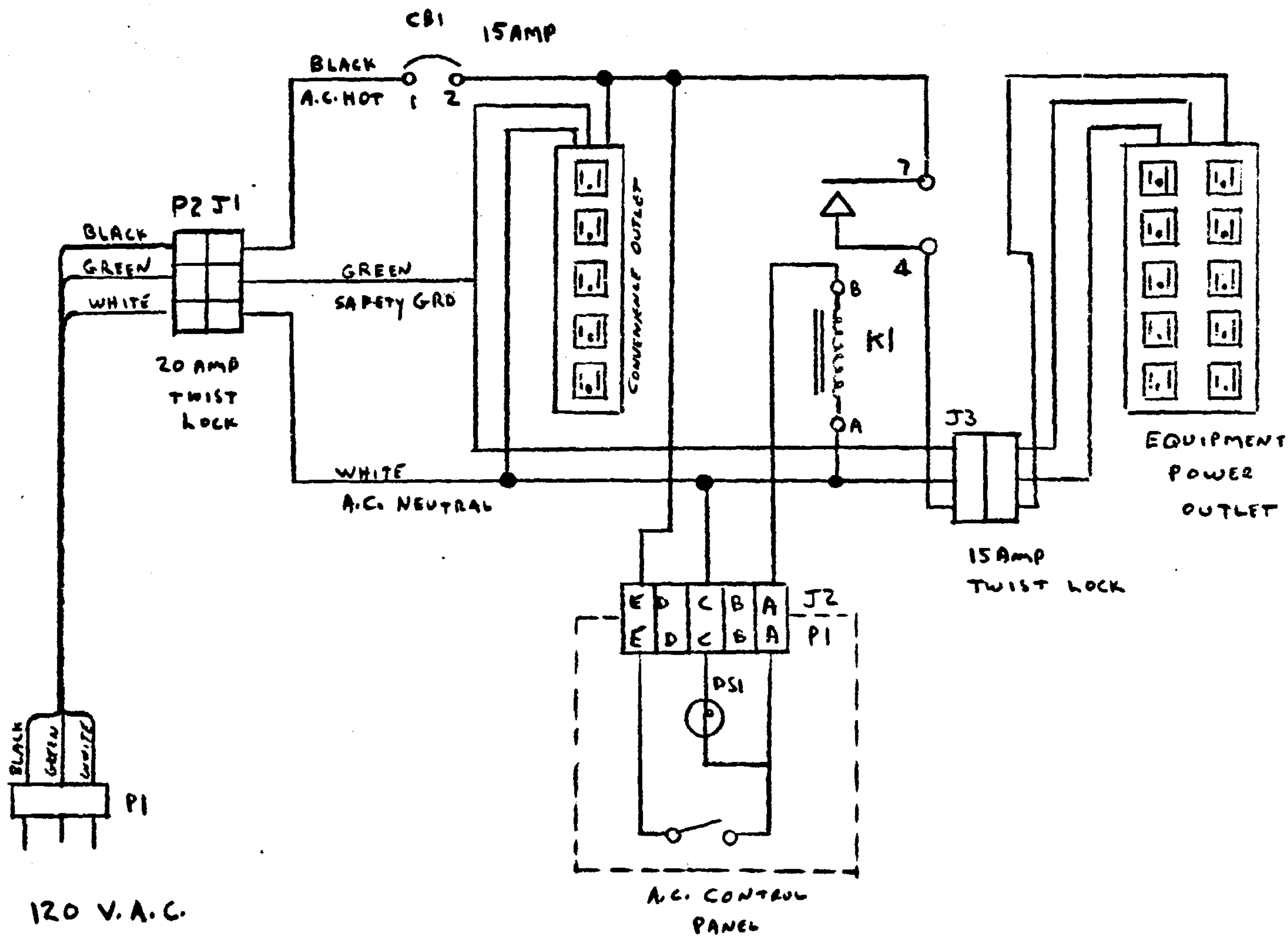
RCA — RCA CORPORATION, NEW YORK, NY — ASTRO ELECTRONICS DIV. PRINCETON, N.J. PLANT

EQUIPMENT RACK LAYOUT PAYLOAD OPERATION T.V. SYSTEM

SIZE D CODE IDENT NO. 49671 SK2299960

SIDE VIEW

FOLDOUT FRAME 1



DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING.

TOLERANCES ON FINISHED DIMENSIONS UNLESS OTHERWISE SPECIFIED

BASIC DIMENSIONS	2 PLACE DECIMALS		3 PLACE DECIMALS
UP TO 6	±.02		±.005
ABOVE 6 TO 24	±.03		±.010
ABOVE 24	±.06		±.015

ANGULAR DIMENSIONS ±1/2°

SEE RCA PURCH SPEC FOR STOCK TOL

FIRST MADE FOR	
NEXT ASS'Y	USED ON

ALL EXTERNAL THREADS TO BE CLASS 2A BEFORE PLATING, AND CLASS 2 AFTER PLATING. ALL INTERNAL THREADS TO BE CLASS 2B, UNLESS OTHERWISE SPECIFIED.

WAS

SYM	ZONE	DESCRIPTION	DATE	APPROVED

REVISIONS

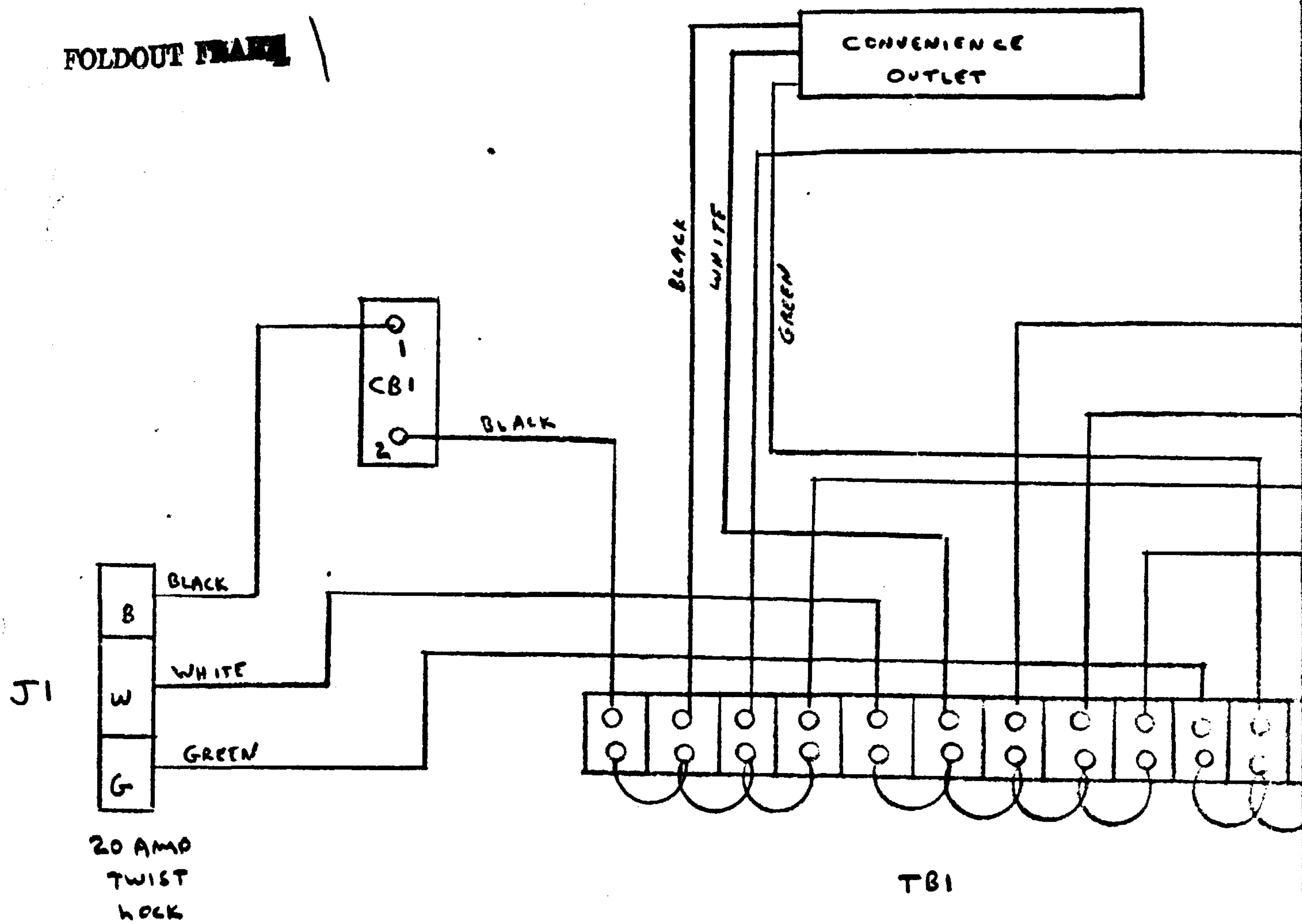
FOLDOUT FRAME 2

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

QTY REQD 504	QTY REQD 503	QTY REQD 502	QTY REQD 501	ITEM NO.	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION
					LIST OF MATERIALS		

CONTRACT NO. NAS9-14617	RADIO CORPORATION OF AMERICA CAMDEN, N.J. PLANT
COMMODITY CODE	SCHEMATIC A.C. POWER CONTROL
DRAWN F.G. HUBIT DATE	
CHECKED DATE	
DESIGN ACTIVITY APPD. J.B. Hult DATE 2-12-76	CODE IDENT NO. 49671 / SIZE B / SK2273858
	SCALE / WEIGHT / SHEET

FOLDOUT FRAME



DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING		
TOLERANCES ON FINISHED DIMENSIONS UNLESS OTHERWISE SPECIFIED		
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	±.02	±.005
ABOVE 6 TO 24	±.03	±.010
ABOVE 24	±.06	±.015
ANGULAR DIMENSIONS ±½°		

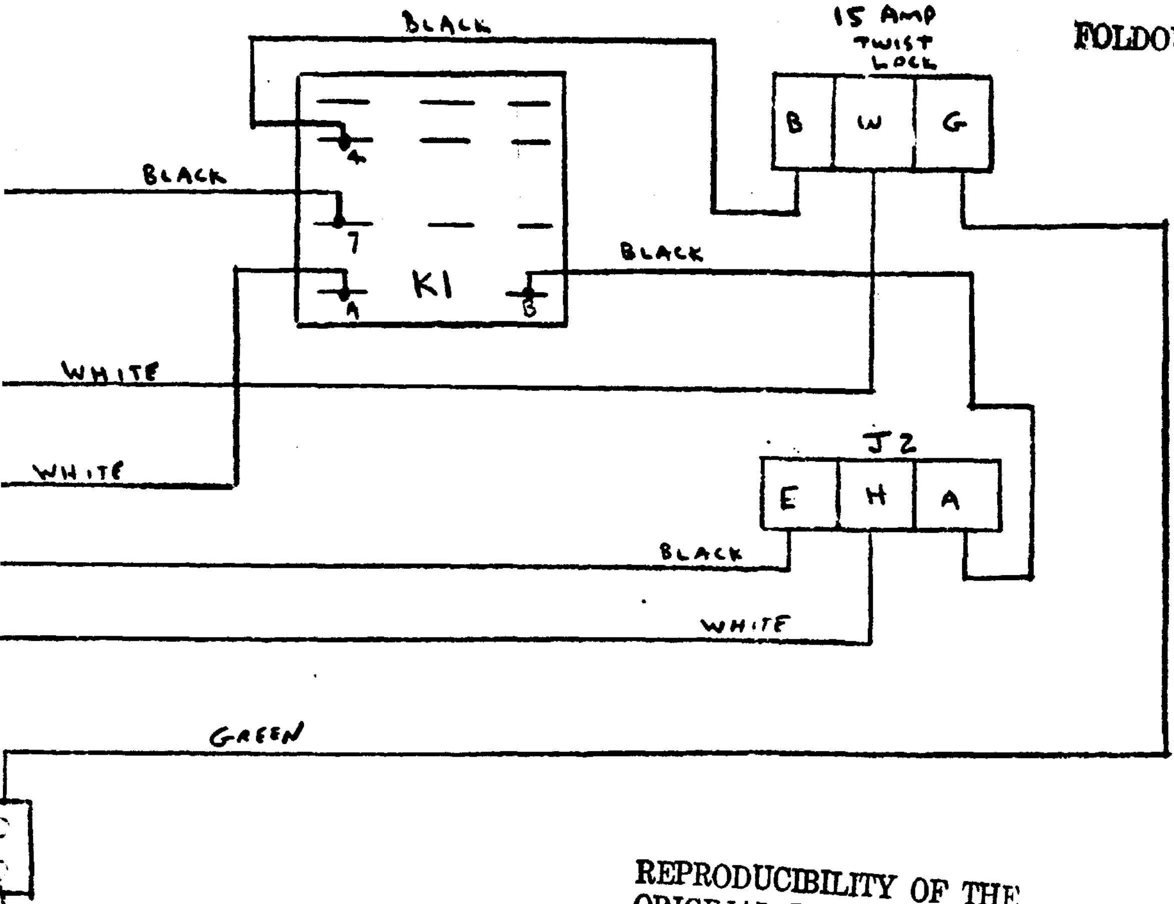
FIRST MADE FOR	
NEXT ASS'Y	USED ON

ALL EXTERNAL THREADS TO BE CLASS 2A BEFORE PLATING, AND CLASS 2 AFTER

WAS

REVISIONS				
SYM	ZONE	DESCRIPTION	DATE	APPROVED

FOLDOUT FRAME 2



REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

QTY REQD	QTY REQD	QTY REQD	QTY REQD	ITEM NO.	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION
504	503	502	501		LIST OF MATERIALS		

CONTRACT NO.	RADIO CORPORATION OF AMERICA CAMDEN, N.J. PLANT
COMMODITY CODE	ASSEMBLY A.C. POWER CONTROL
DRAWN F.G. HUBIT DATE	
CHECKED DATE	
DESIGN ACTIVITY APPD. J. D. Hubt DATE 2-12-76	CODE IDENT NO. 49671 SIZE B SK2273859

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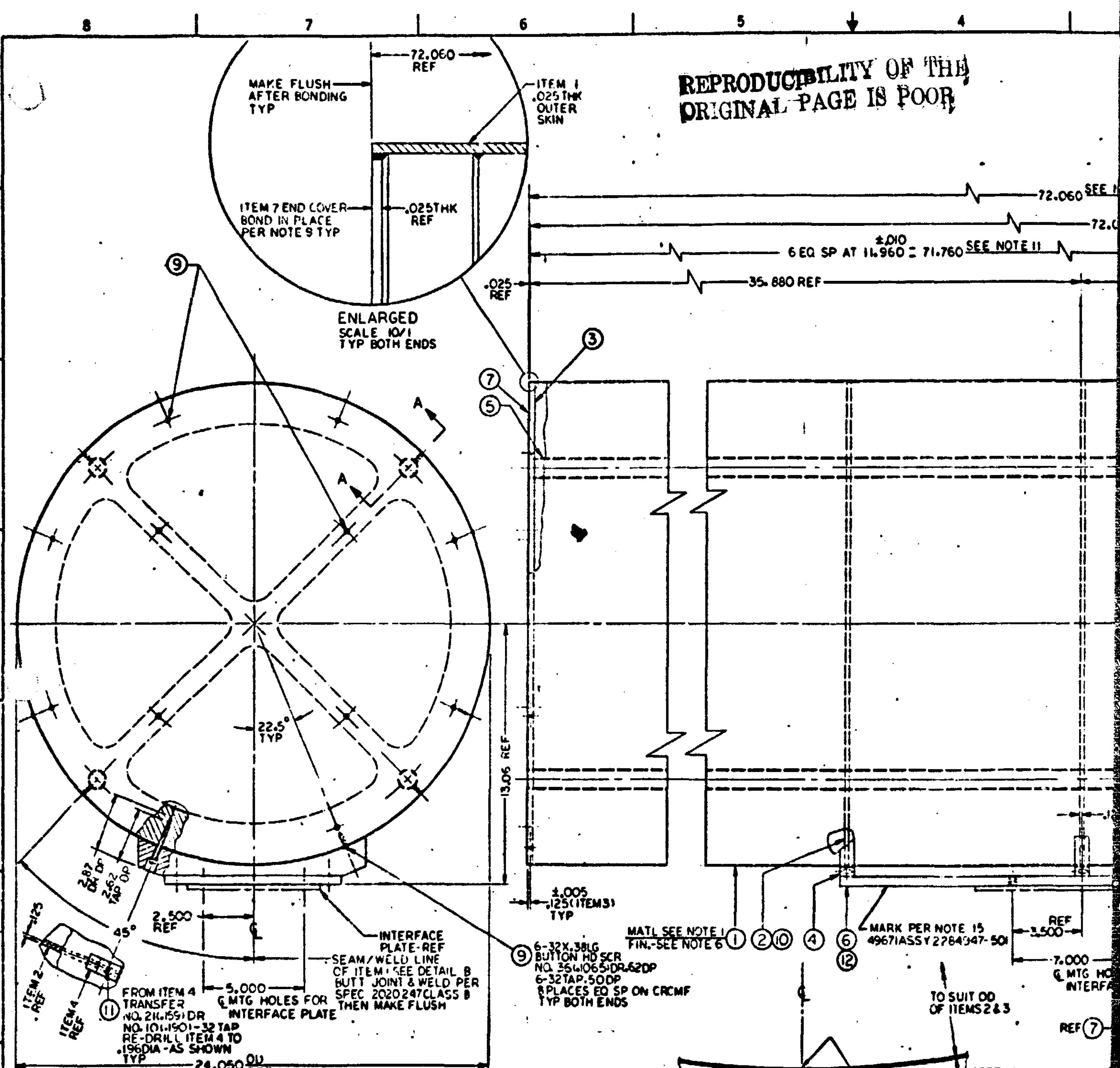
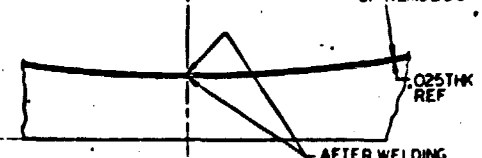
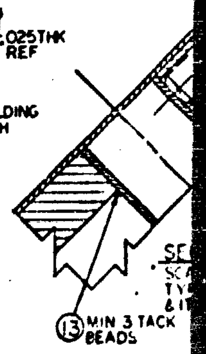




DETAIL B
SCALE 2/1

15-MARK 12HIGH STD CHARACTERS USING ITEM 27 PER ITEM 28.



NOTES:

1-MATL OF ITEMS 1,7,18,21 & 22
AL ALY 6061-T4, QQ-A-250/11C
.025THK (RCA 2010590-425)

2-MATL OF ITEMS 2,3 & 23
AL ALY 2024-T4 QQ-A-250/4C
.250THK (RCA 2010636-591)

3-MATL OF ITEMS 4
AL ALY 2024-T4 QQ-A-250/4C
.750THK (RCA 2010636-595)

4-MATL OF ITEMS 5 & 24
AL ALY TUBING 6061 T6 WW-T-700/6D
1.000 OD X .062 WALL (RCA 2010726-324)

5-MATL OF ITEMS 6
AL ALY 2024-T4 QQ-A-250/4C
.?0THK (RCA 2010636-593)

6-FINISH FOR ALL AL ALY PARTS (EXCEPT NOTED)
CHEM TREAT FOR AL ALY PER MIL-C-5541
(RCA 1960135-1) & TOUCH-UP ALL RE-WORKED
SURFACES AS REQD.

NOTES CONTINUED

7-FUSION WELD TO BE CONTINUOUS & PER SPEC 2020247 CLASS B

8-INSTALL HELICOIL INSERTS PER SPEC 2020312

9-EXCEPT AS NOTED ALL BONDING TO BE CONTINUOUS USING ITEM 13 PER SPEC 2021037.

10-WORKMANSHIP IN ACCORDANCE WITH 8030028

11-ASSEMBLE ITEMS 2,3 & 7 TO DIMS SHOWN & ITEM 5 TO BE FLUSH WITH ITEM 3 ON BOTH ENDS (SEE SECTION A-A) THEN SECURE IN PLACE USING SET SCREWS ITEM 10.

12-DRILL & TAP PRIOR TO BONDING PER NOTE 9. SEE ENLARGED VIEW (ZONE H6-7).

13-MATL OF ITEMS 19 & 20
AL ALY 2024-T4 QQ-A-250/4C
.375THK (RCA 2010636-592).

14-PAINT ENTIRE EXTERIOR SURFACES USING ITEM 25 (PRIMER) AFTER DRYING APPLY TWO COATS OF ITEM 26 (FLAT WHITE PAINT).

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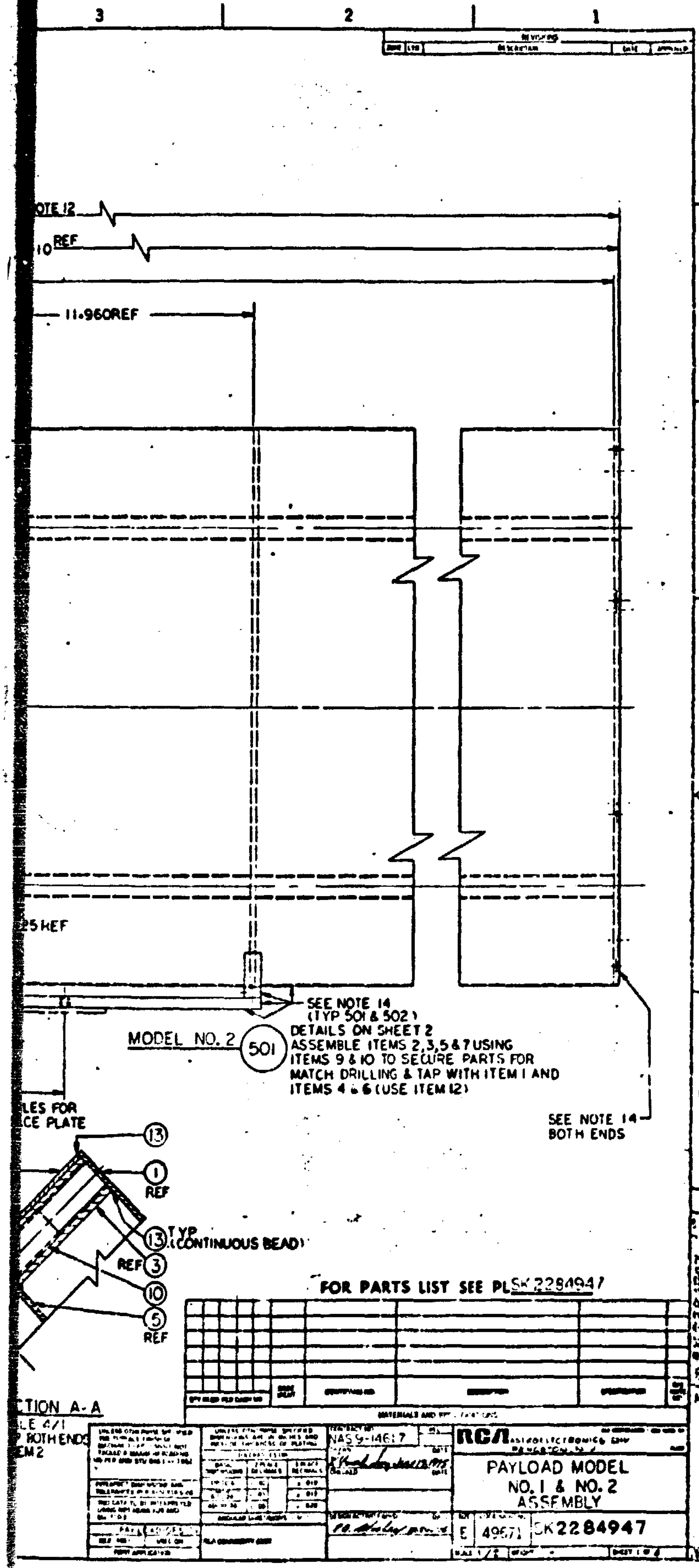

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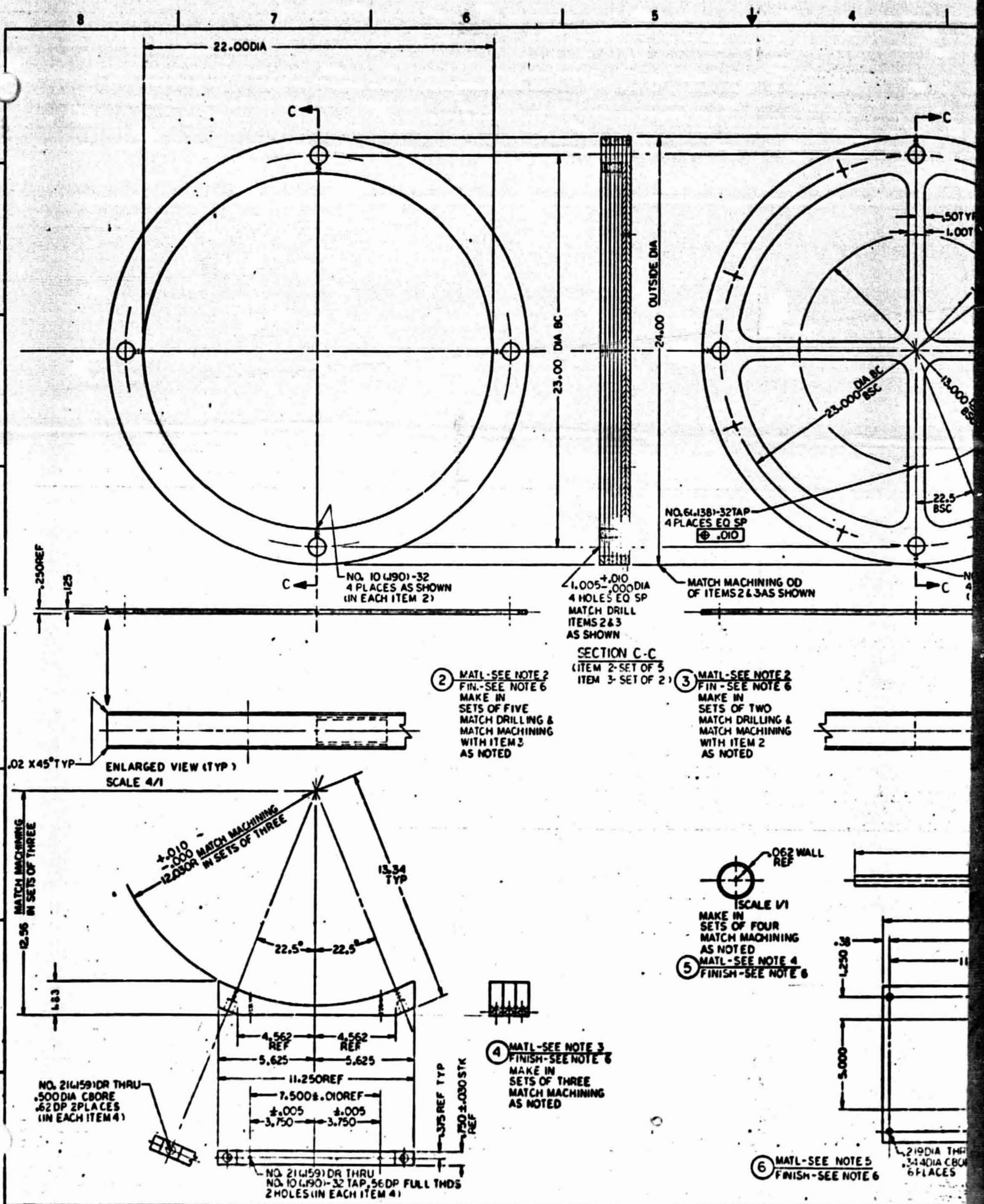

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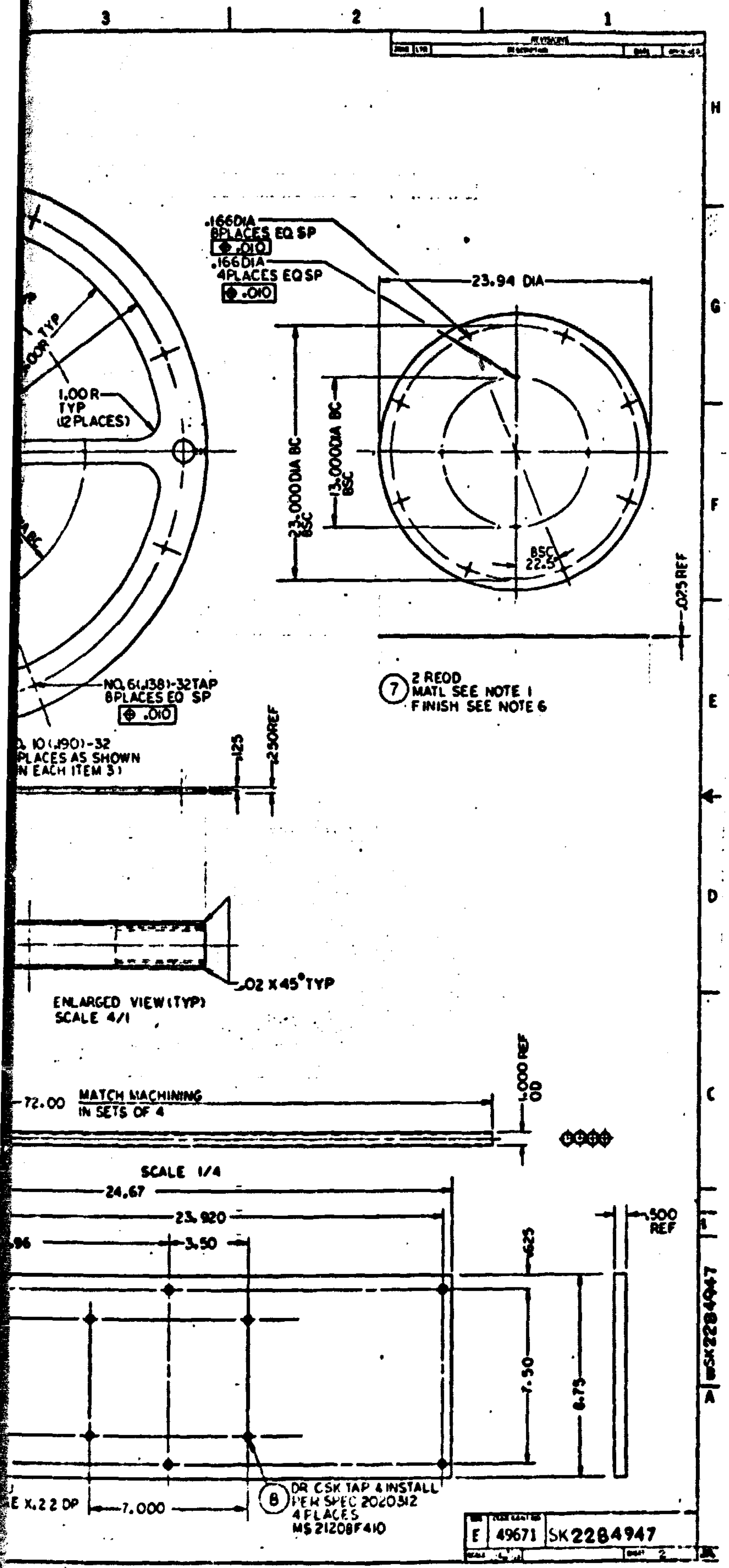

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ORIGINAL PAGE IS POOR

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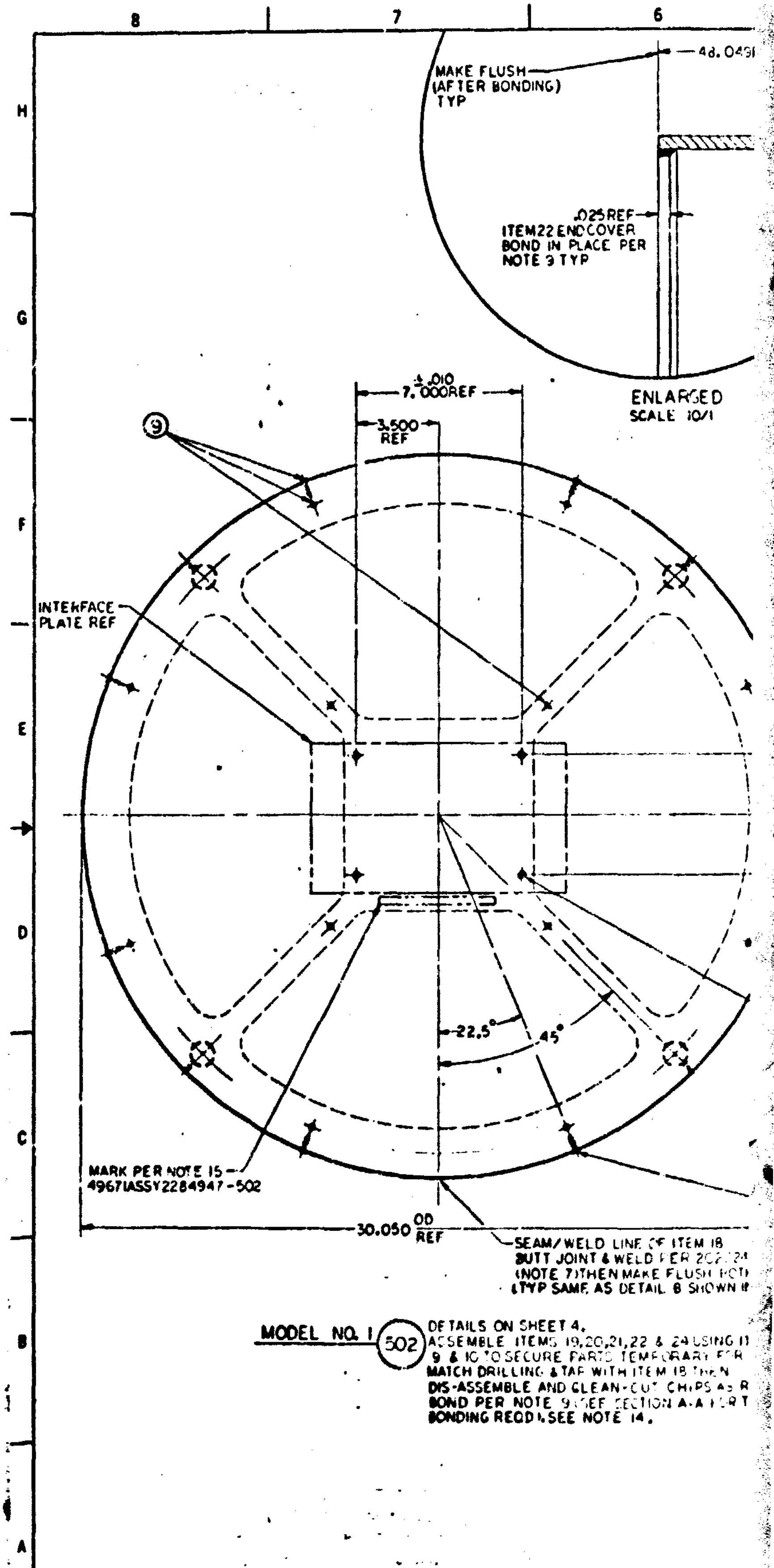

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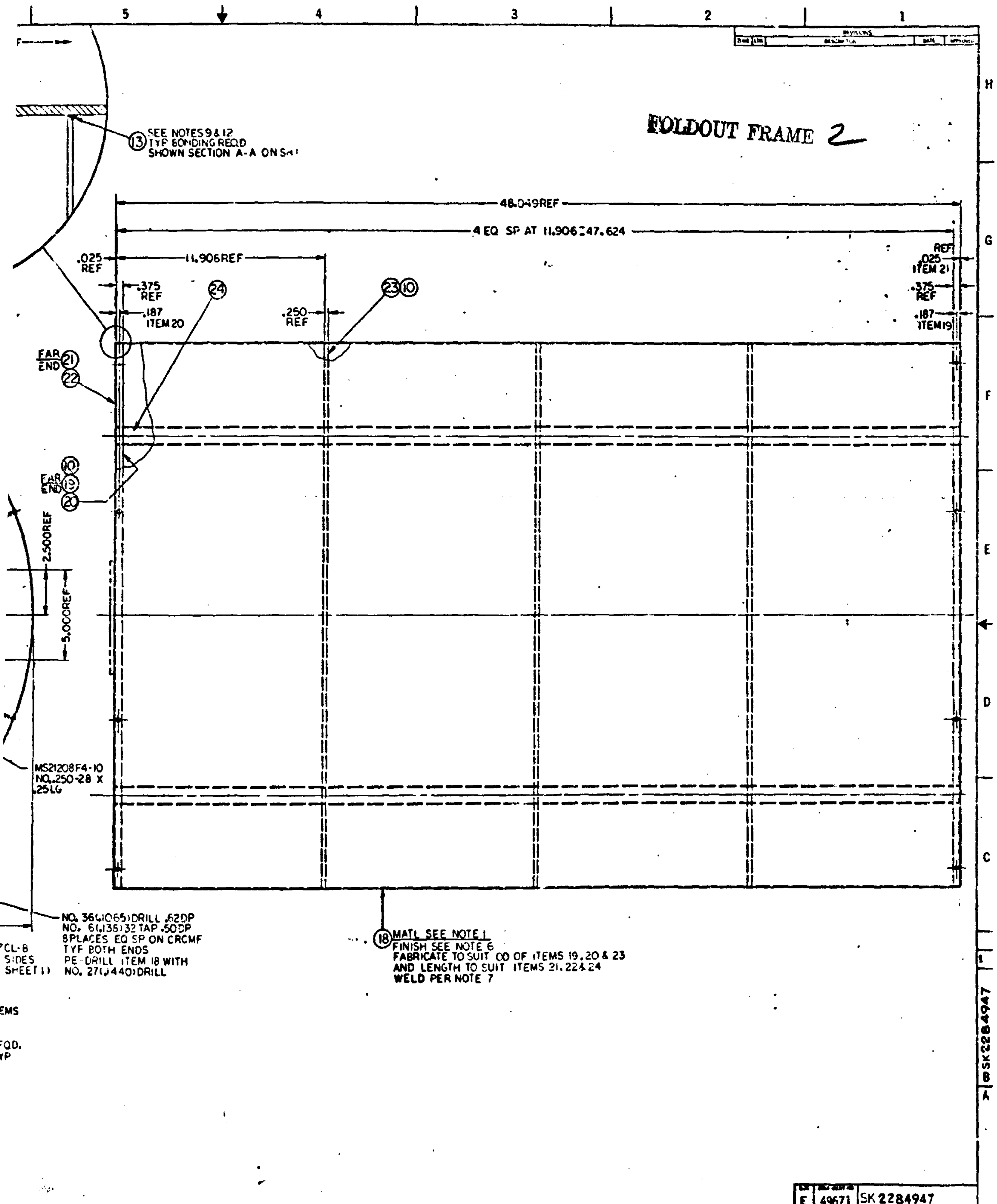

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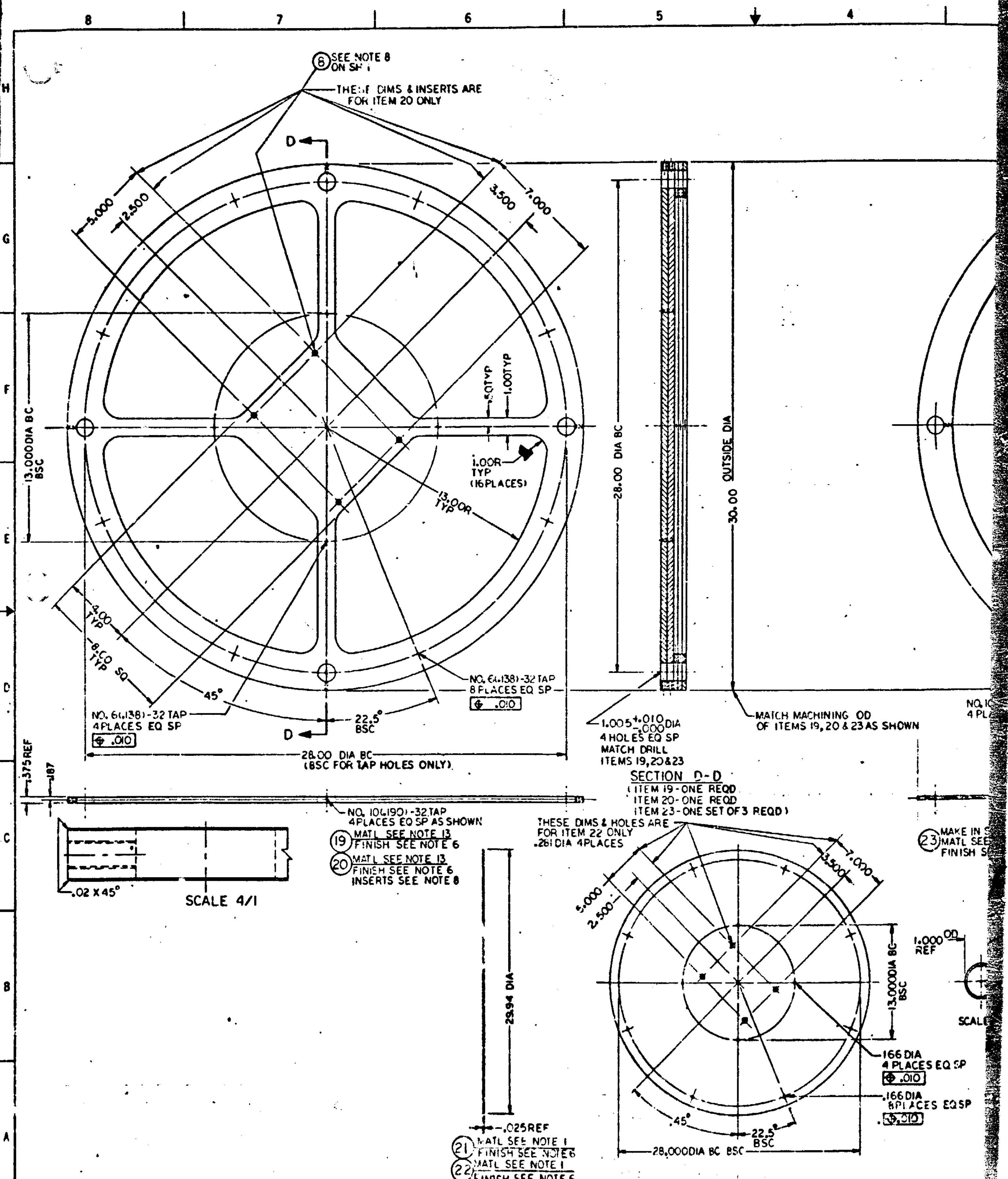

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